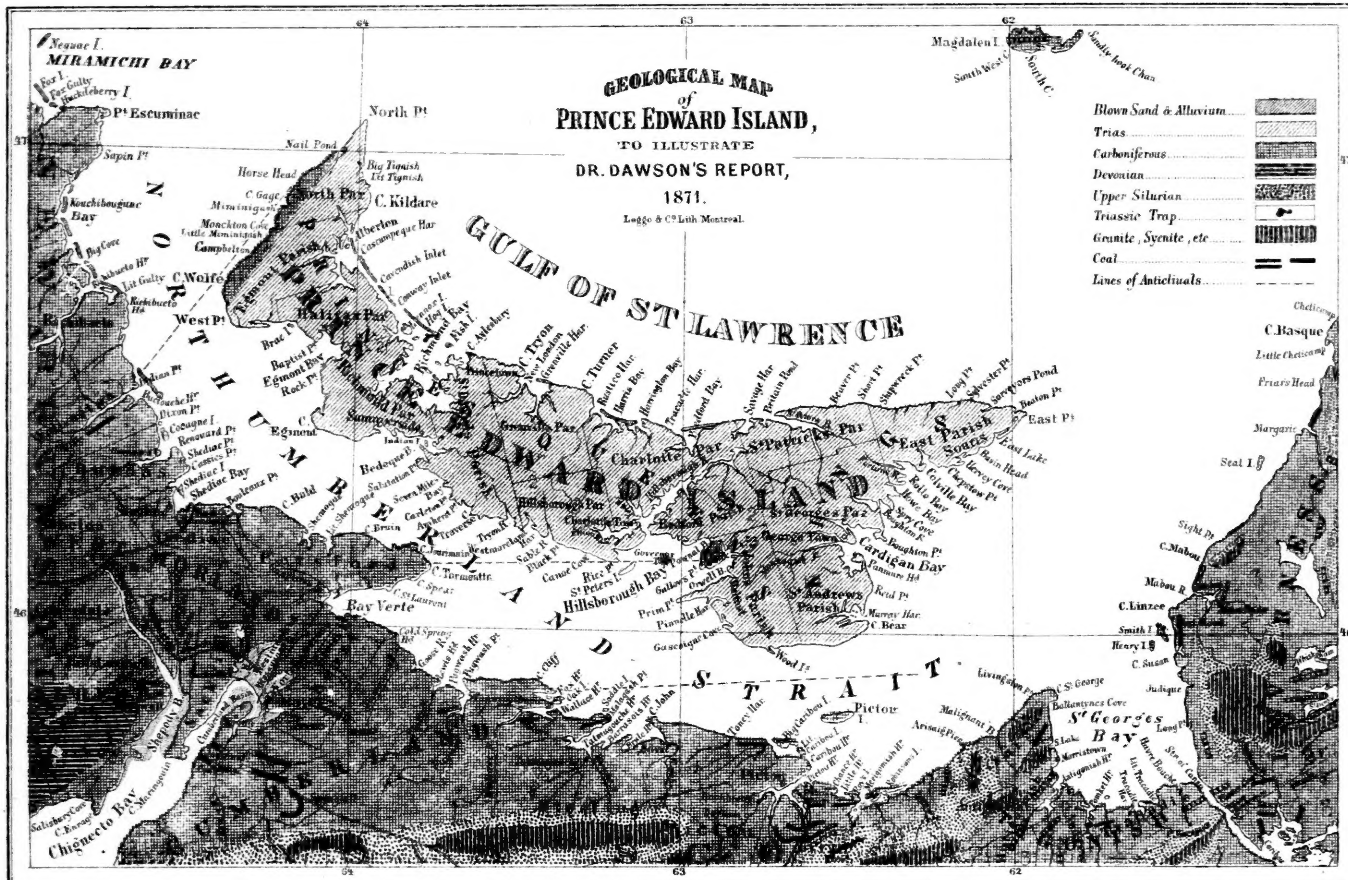

NOTE.— The Geology of N.B.&N.S. is taken from Dawson's Acadian Geology — the Geography from Logan's Map.

REPORT

ON THE

GEOLOGICAL STRUCTURE

AND

MINERAL RESOURCES

OF

PRINCE EDWARD ISLAND.

BEING THE RESULT OF EXPLORATIONS CONDUCTED UNDER THE AUTHORITY OF THE LOCAL GOVERNMENT.

BY

J. W. DAWSON, LL.D., F.R.S., F.G.S.,

ASSISTED BY

B. J. HARRINGTON, B.A., PH. D.

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1871.

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To His Excellency

WILLIAM FRANCIS CLEAVER ROBINSON,

Lieutenant-Governor, &c.

May it please Your Excellency,

I beg leave herewith to present the Report of Geological Explorations, made in July and August, 1871, under the direction of your Government, and in which I was aided by Mr. B. J. Harrington, B.A., Ph. D., who, in addition to performing a portion of the field work, has conducted the chemical examination of the mineral substances obtained.

The plan pursued was, in the first instance, to examine jointly the instructive sections in Orwell Bay and its vicinity; and subsequently Dr. Harrington went northward into Prince's County, while I specially examined the southern and eastern part of the Island, after which I met Dr. Harrington at Summerside, and visited some of the more interesting and important exposures which he had discovered. I also crossed over to Cape Jourimain, on the New Brunswick side of Northumberland Strait, with the view of comparing the rocks there with those of Prince Edward Island. Dr. Harrington had the benefit, during his exploration, of the company and aid of Hon. W. H. Pope; and I was much aided by the kindness of F. W. Hales, Esq., and Daniel Davies, Esq., of Charlottetown, and of Dr. Robertson, M.P., of Montagu. I am also much indebted to Hon. James C. Pope for the interest taken by him in the progress of the work, and for much valuable aid and information. I have further to express our obligations to the Prince Edward Island Steam Navigation Company for free passages in its boats.

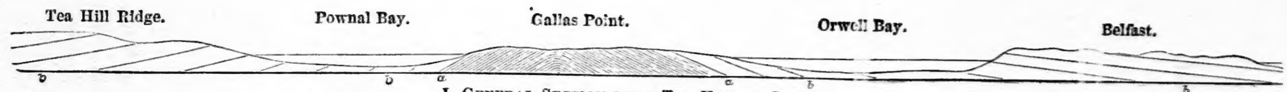
In addition to the facts obtained by our explorations of last summer, the only available sources of information were: (1) A short paper published by me in 1842, in the *Royal Gazette*, and containing the results of explorations at Gallas Point and other places on the south coast. (2) A Report by A. Gesner, Esq., F.G.S., published in 1847, as a supplement to the *Gazette*, and which we found useful in indicating the localities of certain rocks and minerals. (3) The chapter on Prince Edward Island in my Acadian Geology, Second Edition, 1868, in which a summary is given of what was previously known, with some additional facts. (4) Specimens collected by Mr. J. W. Taylor, F.G.S., of Alberton, at Gallas Point, in the course of an exploration undertaken in search of coal.

I have the honour to be,

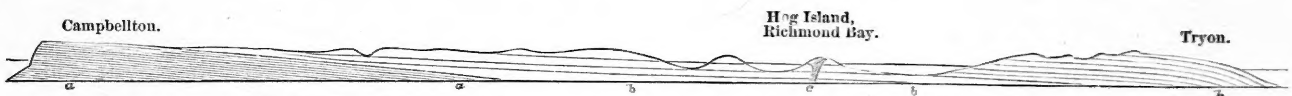
Your obedient servant,

J. W. DAWSON.

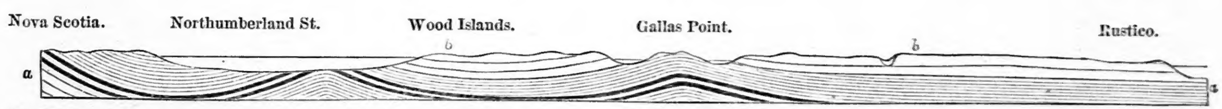
Montreal, November 1, 1871.



I. General Section from Tea Hill to Belfast.



II. General Section across Prince Edward Island, from Campbellton to Cape Tryon.



III. Ideal Section through Gallas Point, showing the probable relations of the Trias of Prince Edward Island to the Carboniferous.

(*a*) Carboniferous. (*b*) Trias. (*c*) Triassic Trap.—in all the Sections.

REPORT ON THE GEOLOGICAL STRUCTURE

OF

PRINCE EDWARD ISLAND.

By J. W. DAWSON, LL.D., F.G.S., F.R.S.,

ASSISTED BY

B. J. HARRINGTON, B.A., Ph.D.

The results of our exploration may be arranged under the following heads:—

1. The General Geological Structure of Prince Edward Island.
2. Relations of the Rock Formations of Prince Edward Island to those of Nova Scotia and New Brunswick, with reference more especially to the Occurrence of Coal.
3. Economic Geology and Notices of Interesting Minerals.
4. Lists and Descriptions of Fossils.

I.—GENERAL GEOLOGICAL STRUCTURE.

The geological formations represented in Prince Edward Island are, in ascending order, or proceeding from the oldest to the newest:—

(1.) Beds of brown, gray and red sandstone and shale, with layers of coarse concretionary limestone and fossil plants. These may be considered as of Newer Carboniferous age, and are similar in mineral character and fossils to beds occurring on the opposite coasts of Nova Scotia and New Brunswick, and there overlying the productive coal measures. These beds occur principally in the Peninsula between Orwell Bay and Pownal Bay, in Governor's Island, in Hillsborough Bay and on the coast between the West and North Capes.

(2.) A series of bright red sandstones usually with calcareous cement, alternating with beds of red and mottled clay and soft red shale, and with occasional white bands and stains and layers of concretionary limestones and conglomerate. They resemble in mineral character, and the few fossils which they afford, the Trias or new red sandstone of Nova Scotia and of Connecticut. In Prince Edward Island this formation may be divided into two members, the lower of which (representing perhaps

the Bunter Sandstein of Europe) is characterized by the prevalence of hard concretionary calcareous sandstones and obscure fossil plants, while the upper (representing perhaps the Keuper of Europe) has softer and more regularly bedded sandstones and clays. One or other of these constitutes the superficial rock over the greater part of the Island, the beds undulating in very gentle synclinal and anticlinal curves. They are probably unconformable to the beds of the formation first mentioned, but these are so slightly inclined that this is not very perceptible. This formation has afforded the remains of the remarkable Triassic Reptile *Bathygnathus borealis.*

(3.) Drift deposits, which overlie the surface of the more solid rocks in the greater part of the Island. These are of three kinds : (1) Boulder clay, consisting of hard unstratified clay or loam, filled with stones which are mostly those of the formations above mentioned, though sometimes of kinds not occurring in the Island. They are often rounded, and are also scratched and polished by the action of ice. (2) Stratified sand and gravel, in some places containing sea shells of species now living and occasional boulders. This deposit is of comparatively rare occurrence. (3) Loose boulders lying on the surface, and which are sometimes of rocks occurring in situ in Nova Scotia and New Brunswick or on the coast of Labrador.

(4.) Modern deposits. The most remarkable of these are beds of peat, dunes of drifted sand, alluvial clays, and the " mussel mud " or beds of oyster and mussel shells occurring in the creeks and bays. Along with these may be considered the evidences of modern subsidence, observed in some places, and ridges of earth thrown up by the ice on the margins of creeks and streams.

The surface produced by these deposits, except the last mentioned, is gently undulating, in broad valleys and rounded ridges not exceeding the height of about 400 feet, and usually much lower. The ridges are produced by the harder beds of sandstone, while the softer layers have been scooped out to form the valleys. The beds being but slightly elevated, and denudation by water having been the chief agent in moulding the surface of the country, it follows that the harder beds of the upper or lower series usually appear in the tops of the rising grounds. These rising grounds and most of the principal ridges and projections of the coast, correspond in direction with the undulations of the Triassic beds, or are nearly East and West Magnetic. The portions of the Island occupied with the Upper Carboniferous Series are more flat than usual ; and this also applies to a portion of the Triassic region north of Bedeque, where the beds seem to have been subjected to severe aqueous denudation.

We may now consider the formations above mentioned more in detail.

1. *Upper Carboniferous Series.*

This formation, as occurring at Gallas Point, was first described, and recognized as a peculiar group, in the paper above referred to, published in 1842. Similar beds were observed at Governor's Island and noticed by Gesner, in his Report of 1847, and a more extensive development of the same series was discovered by Dr. Harrington at Miminigash and its vicinity, in our explorations of last summer.

(1) *Gallas Point.*

Gallas or Gallows Point is the extremity of an oval peninsula about three miles wide and four miles long, lying between Pownal and Orwell Bays. It lies in the axis of a flat anticlinal of the Trias, the red sandstones of Bristol and Point Prim dipping away from it to the southward, and those of Pownal Point and the neighbouring country dipping to the northward. They, no doubt, at one time were continuous, above the Gallas Point beds, but have been removed by denudation.

The best exposure at this place is in the low cliff and on the shore near the extremity of Gallas Point, and thence for a mile and a half to the north; beyond which place the dip becomes changed and the beds are repeated on the opposite side of the anticlinal. On the part of the shore referred to, the dips are South 15° E., at angles of 8° to 10°, and the section presented is as follows in ascending order. In consequence of the low angle of dip, and the undulations and diagonal lamination of the beds, the thickness stated must be regarded as merely approximate :

	ft.
1. Brown and reddish sandstones, with thin bands of concretionary limestones and calcareous conglomerate, with fragments of red clay or shale........	30
2. Red and mottled clay; thin-bedded and alternating with argillaceous sandstones	39
3. Soft reddish sandstones........	75
4. Brown sandstones with gray bands and layers of concretionary limestone, silicified and carbonized trees, Calamites and comminuted plants........	81
5. Concealed by marsh, probably clay and soft sandstone........	99
6. Red and gray sandstone with beds of red and mottled clay........	60
7. Red sandstone with gray and white bands........	93
8. Reddish sandstone and gray bands, with nodules of oxide of iron, and Calamites........	102
	579

Overlying these beds, and with similar dips, are bright red sandstones and red clays with white bands and blotches, and some layers of calcareous conglomerate with obscure fossil plants. These beds I am inclined

to refer to the lower division of the Trias, and to place the line of separation at the cove, in which is Mr. G. Tweedie's landing. Still, as there is no obvious uncomformability of the beds, this must be regarded as to some extent uncertain. We shall return to these beds in considering the Trias.

The beds in the above section are not lithologically very different from those overlying them, except in the greater prevalence of gray, brown and purple beds. They also contain numerous bands of gray and reddish coarse concretionary limestone, and of hard conglomerate or breccia, composed of fragments of red clay and shale cemented by sandstone. Beds of this kind, however, also occur in the overlying Trias. The most abundant fossils in this section are trunks of coniferous trees. These are usually silicified or converted into quartz by the infiltration of silica. Some are, however, infiltrated with the red oxide of iron, and others with carbonate of lime; and in some beds they have been flattened and converted into anthracite coal. The largest seen were about a foot in diameter. Many of them appear to have been much decayed before they were imbedded and fossilized, and the numerous cracks and cavities produced by decay are often filled with crystals of sulphate of baryta, stained of a bright red by the peroxide of iron. They have evidently been drift trunks buried in the sand now constituting the sandstones. They appear all to be of one species, a conifer or pine tree of the Araucarian type, and identical with a species abundant in the Upper Coal-formation of Nova Scotia, and to which I have given the name *Dadoxylon materiarium*.* Some of the specimens show their structures in great perfection, but the greater number have their structure partially destroyed, so that their finer markings are not apparent.

The silicified trunks are mostly in the brown sandstone, but, in certain gray beds, trees of apparently the same species have been converted into coaly matter, and it is the occurrence of these carbonized trees which has given rise to the belief that a coal-bed exists at this place. The mode of occurrence of these carbonized trees may be understood from the following section, taken on the shore of Mr. Tweedie's farm. The order is descending:

	ft.
Brown Sandstones.	
Gray and flaggy sandstones with trees, coaly and silicified..	1
Reddish sandstones, about......	20
Gray and flaggy sandstones and concretionary limestone, and gray clay with many carbonized trunks or branches......	2
Brown and red sandstones.	

* Acadian Geology, pp. 425, 473.

The carbonized trunks are imbedded in clay, which has, probably by resisting the entrance of water, prevented them from being penetrated by silica or other mineral matters. It is obvious that these carbonized trees are of no value as a source of coal, though they aid in proving that the beds in which they occur belong to the upper part of the Carboniferous system. In addition to these trunks there occur at Gallas Point three species of Calamites, resembling in their marking *C. Suckovii* and *C. Cistii* of the Coal-formation and *C. Gigas* of the Permian. Some of the brown sandstones at Gallas Point are sufficiently hard to form good building stones, and there is a bed of gray flaggy sandstone about four feet thick which might afford tolerable grindstones. The concretionary limestones are too impure to be of much value.

(2) *Governor's Island.*

The east end of Governor's Island is occupied by a marsh, probably covering soft beds of shale or sandstone. Proceeding to the northward, the shore presents the following section in ascending order, on the beach and in a low cliff:

	ft.	ins.
1. Gray sandstone and reddish and gray shale	50	
2. Brown shaly sandstones and gray bands	18	
3. Red concretionary limestone and gray bands	3	
4. Brown flaggy sandstone with gray bands and purplish and red shales	9	
5. Red argillaceous sandstone	2	
6. Gray and purple flags	4	
7. Red marly clay with greenish bands and stains	4	
8. Concretionary limestone in irregular lumps	0	6
9. Mottled flags, irregularly bedded	1	6
10. Red marly clay	20	
11. Brown and gray sandstones, waving in an undulating manner for some distance	15	
12. Red and gray clay and arenaceous shale	15	
13. Coarse gray sandstone, stained in places with green carbonate of copper, and with nodules of the gray sulphide of copper, and plants fossilized by sulphide of copper	16	
14. Brown sandstone	20	
15. Red and greenish clay	10	
16. Coarse thick-bedded dark gray sandstone	30	
	218	

The greater part of these beds dip N. 22° E. to N. 30° E. at angles of 12° to 15°.: but the last mentioned bed (No. 16) is broken by a small fault, beyond which it dips N. 10° E. at an angle of 20°.

On the west side of the Island a repetition of the section is seen, and on this side the lower gray beds contain Calamites and fossil Carpolites of the genus *Trigonocarpum*. The beds at Governor's Island probably

belong to the north side of the Gallas Point anticlinal, and are apparently a little lower in the series than those seen at the latter place.

(3.) *Miminigash and Campbellton.*

Until Dr. Harrington visited this place its rocks were not known to be fossiliferous, though Gesner had mentioned sandstone and limestone as occurring on the coast.

Between Little and Big Miminigash, the coast shows a good section of beds dipping very slightly to the south-east, their strike running nearly in the direction of the shore, so that no great thickness is exposed, except by slight undulations of the beds, and the occasional considerable height of the cliffs. In one place the following section was observed in ascending order:

	ft.	
1. Concretionary limestone, red and mottled, and consisting of large limestone balls imbedded in marly clay	3	
2. Space probably occupied by soft red sandstones	10	
3. Purplish red sandstone and red and mottled shales	6	
4. Flaggy red sandstone and shale, Ferns and Cordaites	5	
5. Shale and sandstone	10	
6. Shaly sandstone	1	
7. Red shale	5	
8. Thick beds of coarse brown sandstone	50	or more
	90	

Between little Miminigash and Campbellton the upper sandstones descend and occupy nearly the whole cliff, which beyond Campbellton increases in height, and is cut into deep coves and projecting points by the waves. In these sandstones are silicified coniferous trees of the same species with those of Gallas Point. At some distance south of Campbellton the cliff is again occupied by laminated red sandstones and shales which seem to rest on the brown sandstones in ascending order, so that the whole thickness seen is perhaps 150 feet. It is difficult, however, to estimate the thickness of beds undulating along a strike shore and very irregular, the sandstones often being replaced by shale.

The following section was taken by Mr. Harrington at Campbellton:

	ft.	ins.
Diluvium	2	
Reddish sandstone, much jointed and in places a good deal laminated	12	
Compact sandstone, hard and coarse-grained, stained quite red on the surface, but having a rather gray appearance when freshly broken; containing small clay concretions	9	
Conglomerate limestone, reddish gray and in places bleached quite gray	1	6
minated red clay, here and there bleached gray	2	
	26	6

Some of the compact sandstones might be used for building purposes, but are of inferior quality; they are said to make excellent grindstones, but appear to be too coarse.

The beds on this shore differ very little in mineral character from those of the Trias. They are rather more laminated and micaceous, and are rather harder and more distinctly jointed, the latter peculiarity gives a much more angular and broken character to the cliffs than is visible in the Triassic districts; but their chief peculiarity consists in the fossils, which are identical with those of the newest member of the Carboniferous series in Nova Scotia, where red beds often prevail in this part of the series.* The more important of these fossils are:

Calamites Suckovii, Brongt.
Cordaites Simplex, Dawson.
Walchia (Araucarites) gracilis, Dawson.
Walchia robusta N. S.
Pecopteris arborescens, Schlot.
" (allied to oreopteroides)
" rigida, Dawson.
Neuropteris rarinervis, Bunbury. (Variety).

The beds characterized by these fossils in Nova Scotia may be regarded as the equivalent of the Fern and Asterophyllite Zones of the German geologists, which in that country form the upper member of the Carboniferous system immediately underlying the Permian. They are also probably the equivalent of the upper part of the Upper Barren Coal-measures of England. They may be equivalent in age to some portions of the so-called Permo-Carboniferous of the western parts of America; but their mineral character and fossils are so different that it is not easy to compare them with the latter.

The question may be raised whether these upper members of the Carboniferous, as developed in Nova Scotia and Prince Edward Island, may not be in reality contemporaneous with the Permian of Europe. This, which is purely a question of theoretical geology, I propose to discuss elsewhere, after I shall have carefully compared the fossils. In the meantime, however, for the reasons stated in discussing the equivalent beds in Nova Scotia in my Acadian Geology, I regard them as Upper Carboniferous.

2. *Triassic System.*

The beds of this series are chiefly soft red sandstone, associated with red and mottled clays, and hard calcareous sandstones and conglomerates, the latter sometimes passing into thin bands of coarse arenaceous limestone, which in some places is a dolomite or magnesian limestone.

* Dawson's Acadian Geology, pp. 217, 326.

In the section in Orwell Bay immediately succeeding in ascending order the Gallas Point series already described, they present the following sequence in ascending order:

		ft.
1.	Bright red sandstones with white bands	30
2.	Red shales with white stains and red sandstones with cylindrical casts of fucoids	60
3.	Red and purplish sandstones with gray bands and layers of ferruginous conglomerate with obscure remains of plants	88
4.	Beach, probably representing soft beds	48
5.	Red flaggy sandstone with conglomerate and concretions of red oxide of iron, containing remains of plants	50
6.	Bright red sandstones and red shale with greenish stains	30
7.	Marsh, probably soft beds	24
8.	Red shale and green bands capped with bright red sandstones	75
		405

(Here the section is broken by Orwell Bay, which probably represents some thickness of soft beds.)

9.	On the high cliffs near Belfast are very bright red sandstones and shaly beds, with gray blotches and cylindrical fucoids—about	120
10.	Over the last, are seen, in the country east of Belfast, soft red sandstones with beds of conglomerate with rounded quartz pebbles and arenaceous cement (thickness uncertain.)	
		525

As seen in this section the whole thickness of these beds cannot much exceed 500 feet. Of this the lowest 270 feet, being Nos. 1 to 5, inclusive, of the above section, may be referred to the lower division, and the remainder to the upper division of the formation. The dips of this series are so low, and the beds so much affected by oblique stratification, that they cannot be said to be unconformable to the underlying Carboniferous rocks, and for this reason as well as on account of the similarity in mineral character between the two groups, some uncertainty may rest on the position of the line of separation. That above stated depends on fossils or a somewhat abrupt change of mineral character, and on a slight change in the direction of the dip. The fossils of these beds consist of obscure striated stems, slender branches with frequently interrupted ridges in the manner of *Knorria*, and which are perhaps branches of pines, and fragments of stems with indications of a transversely marked *Sternbergia* pith.* Assuming for the present that the beds above described constitute two members of the Triassic Series, in tracing these throughout the remaining districts of the Island, we shall

* Possibly also a Cycadean stem. See below under List of Fossils.

find that they present very uniform characters, and that they undulate in very flat synclinals and anticlinals.

Beginning at Wood Islands, we find the Lower Triassic beds stretching along the coast with dips of N. 10° E. to N. 15° E. at angles of 10° to 15°. They consist of hard, reddish conglomerate and calcareous sandstone, with soft red sandstone and red and mottled clay. The thickness seen is about 200 feet. The conglomerates contain pebbles of quartz and of various metamorphic rocks, and also of gray sandstone. Further east the conglomerate becomes less important and the proportion of red sandstone greater. At Cape Bear and the mouth of Murray Harbour, the strike turns to the northward, the dip being N.W. to N. 75° W. Between Murray Harbour and Cape Bear there are hard layers of calcareous conglomerate containing imperfectly preserved plants similar to those of Orwell Bay, and probably belonging to the lower part of the series.

The anticlinal which brings up the Carboniferous beds at Gallas Point, in extending to the eastward, flattens out and does not show any rocks older than the Trias in the country adjoining Montague River and Cardigan Bay, which is in its line of direction. Between this line and the coast of Northumberland Strait, the beds form a very flat synclinal, and the upper conglomerate sometimes caps slight eminences, while the intervening valleys have beds of gravel derived from its waste. These features are well seen on the road from Charlottetown to Wood Islands. Throughout this part of the country rounded masses of the red sandstone, derived apparently from the denudation of the boulder clay, abound on the surface and are much used by the farmers in the construction of fences.

North of Cardigan Bay, the lower member of the Trias seems to prevail, and is well seen at Souris and along the north shore from St. Peter's towards East Cape. Along the latter shore it is often well exposed, and the hard calcareous members are cut by the sea into fantastic forms. The sandstones here abound in the cylindrical plants mentioned above. They vary in size from slender threads to several inches in thickness, usually cross the beds, and are of greenish colour. The large specimens may have been increased in diameter by the addition of concretionary matter. Some of the beds have also numerous cylindrical marks like casts of worm-burrows. In this part of the country a slight transverse undulation of the beds seems to occur in the line of St. Peters and Fortune Rivers.

Throughout the north eastern corner of the Island the lower member of the Trias prevails, the upper member occurring principally on the rising grounds.

Returning to the anticlinal at Gallas Point, the Triassic rocks resting on its northern side appear on the shore of Pownal Bay, dipping at low angles to the northward, and the upper member of the series forms the range of hills from 150 to 350 feet in height extending eastward from Tea Hill. In these hills are some red beds, affording a serviceable building stone.

With similar dips these beds cross the mouth of Charlottetown Harbour and extend along the West River. Here the dips change to N. E. and S. W., and in the middle section of the Island, extending from Hillsborough River to Bedeque, the Trias forms very low undulations, the lower member occurring along the coast and the upper member appearing in the ridges.

Immediately in the rear of Charlottetown one of these upper beds is worked as a building stone. It is soft and of a red colour, resembling in these respects the red beds of the Upper Series in most parts of the Island. We observed, however, that this stone hardens by exposure to the air, and, when carefully selected and not saturated with sea water, it seems to be of durable quality. Still better stone, however, both gray and red, occurs on the Bannockburn Road, and will be referred to in the sequel. At Sable River, Crapaud and Tryon, fragments of silicified coniferous wood are found on the shore and in the fields. The rocks seen in place here are irregularly bedded red sandstones with a general dip to the N. E. at a low angle. They appear to belong to the Lower Trias, and on this account I was very desirous to ascertain if the fossil wood, which seems to be the same species found at Gallas Point, occurs in them in situ. I was not successful, however, in finding any specimen actually in the rock; still from its abundance and unrolled condition, I infer that its source cannot be at any great distance—possibly in reefs of Carboniferous rock, near the shore or immediately under the superficial Trias; and it is to be observed that the outcrop of the Carboniferous beds should here be at no great distance out at sea.

At the end of Cape Traverse hard red calcareous sandstones appear in the beach and are quarried for rough building purposes. Associated with these are soft red sandstones. These beds are nearly horizontal, with a slight dip to the south-west, and appear to belong to the lower member of the Trias. Similar beds appear in Sea Cow Head, also dipping to the southward; but farther inland, the upper member of the Trias appears, at first nearly horizontal and then dipping to the N. E.

Dr. Harrington, who explored the country around Bedeque, Richmond and Cascumpeque Bays, and toward Cape Egmont, West Cape, and Cape Kildare, reports everywhere the prevalence of the Triassic red

sandstones associated in many places with layers of coarse arenaceous limestone, and usually in a nearly horizontal attitude. Over a large part of the area the upper member seems to have been removed by denudation. Dr. Harrington specially mentions the following as points of interest.

Rocks of Triassic age appear to occupy the larger part of the western end of the Island, but the denudation seems to have been much more extensive than in the east; and west of New London the uppermost beds of the Trias are nowhere seen.

The lower series, containing the conglomerate limestones, is, however, everywhere well represented, and the sandstones, unlike the upper beds as seen in Orwell Bay, are very much laminated, and exhibit false bedding to a far greater degree. They are consequently altogether inferior for building purposes.

Aside from the rocks of the west coast, the lowest rocks west of a line drawn from New London to Summerside appear to be those found at Mill's Point, just below the mouth of Indian River. The rocks at this place contain fossils, and bear a considerable resemblance to those of Penn Point, Orwell Bay; but the conglomerate limestone is a true conglomerate, containing quartz pebbles.

The rocks of the western half of the Island are horizontal or have merely a slight undulation, so that no distinct anticlinal or synclinal lines can be made out. The valleys on the road from Darnley to New London are not the result of disturbance, but seem to have been cut through the perfectly horizontal strata. The hills there are all capped with the hard concretionary limestone. Cape Tryon appears to be the beginning of a synclinal, and the rocks are higher than the greater part of those spread over the western part of the Island and more inclined.

The country in the vicinity of Summerside is flat, and the geology for the most part uninteresting. In general, where any rock comes to the surface here, it is the conglomerate, which, being harder than the overlying sandstones, was not swept off by denudation.

The following sections, taken at Indian Point, opposite Summerside, give an idea of the general character of the rocks in this region:—

Section on S. side of Indian Point.

	ft.	ins.
Measures concealed	8	
Compact red sandstone	1	
Laminated " "	1	
Red sandstone, containing irregular concretionary masses of impure limestone	1	6
Laminated red sandstones	8	
Conglomerate limestone	1	
	20	6

Section on S.W. corner of Indian Point.

	ft.	ins.
Measures concealed	10	
Conglomerate limestone, with irregular masses not exhibiting the conglomerate character	2	
Laminated sandstone	1	6
Concretionary limestone	0	6
Compact red sandstone	0	10
Concretionary limestone	0	10
Compact red sandstone	5	
Concretionary limestone		
	20	8

The rocks here have a very slight dip to the N. E. On going N. E. from Summerside towards New London, the only locality of any particular interest is Mill's Point, just below the mouth of Indian River.

The rocks appear to be older than any others in this region, and consist of gray and brown sandstones, containing a bed of true conglomerate with quartz pebbles, and also large concretionary masses of impure limestone (calcareous sandrock). In the latter fossil plants were found, the woody matter in every case being replaced by carbonate of lime. These plants have been ascertained to consist of coniferous wood much decayed and perforated by burrowing animals before its fossilization. The "Corallines," noticed by Gesner, were also seen, but are probably fragments of plants.

It is possible that these beds were forced up at the time of the Hog Island trap eruption, as they appear to have been somewhat broken and distorted. They are succeeded by about 60 feet of brown laminated sandstones with strike N. 15° E. and dip E. 15° S. at an angle of 10° Just at the base of the sandstones a good deal of red clay was seen scattered about the beach, but no bed appeared in situ. The shores of Indian River are very low, so that no rocks could be seen higher than the above-mentioned sandstones.

Northward of Indian River the country is low and flat, and the shore was not visited until reaching Darnley Bridge. Here the rocks are nearly horizontal, and consist of about 15 feet of brownish red micaceous sandstones.

On the north side of Darnley Basin, just below Mr. Francis McNutt's house, the rocks are horizontal, consisting of reddish brown sandstone overlaid by red and mottled clays.

The following is a section :—

	ft.	ins.
Boulder clay	2	
Brownish-red micaceous sandstone	6	
Reddish clay	6	
Grayish white and mottled clay	1	6
Reddish-brown clay	4	
Gray bleached sandstone	1	6
	21	

It will be noticed that no conglomerate limestone appears in the above section: but on going southward for a few hundred yards portions of the clays are seen to change into the so-called conglomerate, which interstratified with thin beds of sandstone occupies a thickness of 4 to 5 feet.

On going from Darnley towards Cape Tryon, the country for several miles is very flat, but then becomes quite hilly, and from the appearance of the ridges which run nearly at right angles to the coast, one would expect to find the rocks somewhat tilted, but on descending to the shore they are seen to be perfectly horizontal until a short distance beyond the Hon. Mr. Montgomery's.

The valleys have been cut out of the horizontal strata, and are not the result of disturbances beneath. The rock which outcrops at numerous places along these hills is the hard conglomerate limestone which has been able to resist denudation while the shaly sandstones have been washed away. This fact may also be noticed to the south and at many places in the western part of the island.

The following is a section north of the Hon. Mr. Montgomery's :—

	ft.	ins.
Boulder clay	3	
Red laminated sandstone	1	6
Conglomerate limestone	1	
Compact red sandstone	2	
Conglomerate limestone with clay concretions predominating	2	
Laminated red sandstone	6	6
Conglomerate limestone	0	6
Compact red sandstone mottled with oxide of manganese	3	
Conglomerate with numerous large clay (red) concretions	1	
	20	6

All the beds are very irregular: thus the lower band of conglomerate changes within a few yards to a bed of red clay, and a bed of clay may be seen to change to sandstone or *vice versa*.

At Cape Tryon, the rocks are the ordinary red sandstones with beds of conglomerate and red clay with bleached layers. The sandstone contains a good deal of manganese, and in places is traversed by numerous little veins of calcite, ½ in. to 1 in. thick. Instead of being horizontal, however, there is an average dip of about 14°, S. 15° E.

These rocks, as stated before, are probably higher than most of those in the western part of the Island. It was at New London, and probably in the lower part of the Upper Trias, or upper part of the Lower Trias, that the jaw of *Bathygnathus borealis*, (Leidy), the most interesting animal fossil hitherto found in Prince Edward Island, was discovered. See list of fossils infra.

In connection with the geology of this part of the Island it may be well to give a section taken at Large Curtain or Burnbury Island:

	ft.
Boulder drift	4
Laminated red sandstone	9
Red conglomerate limestone	1
Laminated red sandstone	6
	20

This is at the northern corner of the Island, where the strike is nearly N. and S., and the dip W. at an angle of 5° to 10°. This dip is merely local, and the rocks of Burnbury Island are on the whole horizontal. The conglomerate limestone thickens in places to 2 or 2½ feet, and concretionary masses like those on Indian Point, only much smaller, are seen here and there.

Going westward from Summerside towards Cape Egmont, there are several outcrops, and among them one at the saw mill on Muddy Creek. Here the rock consists of hard conglomerate limestone with numerous quartz pebbles underlaid by laminated sandstones.

At Cape Egmont the strata have a dip of about 4° to the N. E.

The following is the series as occurring at this place:—

	ft.	ins.
Black peaty soil	1	6
Gray clay	1	6
Red clay with quartz pebbles and small boulders	8	
Laminated red sandstone	5	
Conglomerate limestone, with numerous large concretions of red clay, and interstratified with thin beds of red sandstone	3	
Laminated and shaly red sandstone	15	
Laminated red sandstone, but with more regular bedding than the above	6	
Compact reddish calcareous sandstone (very hard)	2	
Compact and laminated sandstone	5	
Impure limestone (calcareous sandrock) in irregular patches, thickness not ascertainable		
	47	

Cape Kildare.

The following is a section taken at the extreme end of the Cape:—

	ft.
Reddish drift, with small pebbles	5
Laminated red sandstone	7
More compact red sandstone, with calcareous concretions several feet long and about one foot thick	3
Hard calcareous sandstone interstratified with soft layers, the calcareous portion being represented in places by the ordinary red conglomerate limestone	7
	22

Section north-west of Cape Kildare :—

	ft.	ins.
Drift, with a few small pebbles	1	
Laminated red sandstone	3	
Red sandstone not so micaceous as the above	3	6
Conglomerate limestone, red and mottled	1	3
Laminated red sandstone interstratified with thin calcareous layers	2	
Laminated red sandstone	0	10
Conglomerate limestone	1	6
Compact red sandstone	0	6
Conglomerate limestone	0	2
Compact red sandstone, in places calcareous	5	
	18	9

The conglomerate limestones are very largely developed here, but are not of any better quality than the average. The strata appear to be perfectly horizontal, but exhibit a great deal of false bedding. The cliffs are washing away very rapidly. Some of the sandstones are mottled with manganese. Along the beach, a few hundred yards from the point where the last section was taken, fragments of red sandstone and conglomerate limestone, about an inch in thickness and three or four inches across, have been heaped up so as to form a bar four feet high.

A few miles south of Cape Kildare the following section was taken :—

	ft.	ins.
Boulder drift	3	
Reddish sandstone, with calcareous layers	6	
Laminated red sandstone	2	
Conglomerate limestone	1	
" " interstratified with clay	1	2
Clayey red sandstone	3	6
Hard calcareous layers in places becoming conglomerate	1	
	17	8

The strata are here horizontal, but show much false bedding.

Trap of Hog or George Island.—Although the Triassic rocks of the United States and Nova Scotia have been very extensively disturbed by igneous action, those of Prince Edward Island have suffered but little disturbance, and the great ridges to the south are here represented by only one small outlier on the northern coast.

At the north-eastern corner of Hog Island a mass of trap makes its appearance, its dark colour contrasting strangely with the bright rocks of the neighbouring Islands. The trap forms a diminutive promontory, about six feet high. It is apparently a dyke, and its direction is about S. 15° W. It can be traced for a few hundred yards along the eastern shore, and then disappears. In places there are two series of joints, one running S. 15° W., and the other S. E.

The parts exhibiting this jointed structure are very hard and compact, but where it is wanting the trap frequently becomes amygdaloidal, the cavities being for the most part filled with a white mineral, which proved to be Saponite, a hydrous silicate of alumina and magnesia. The upper portion of the mass is partially covered with what seems to be a sort of scoria, and which has a very rough and irregular surface. The general colour is dark gray, and there are spots of a dark purple and red colour, which may be merely stains, or may perhaps be due to included pieces of some aqueous rock.

The trap was carefully examined in order to discover whether any fragments of rocks from below had been brought up, but nothing except a small piece of gray sandstone was found.

The immediate contact of the trap and red sandstone was nowhere seen, but at one spot the sandstone which cropped out above the trap was found to be baked and hardened. At the south-western end of the Island the sandstone did not appear to be altered in the least, nor was it at all tilted. The only evidence of disturbance anywhere in this region was on the north shore of Large Curtain Island, where the rocks were slightly tilted and broken.

The trap of Hog Island, more especially its compact portion, resembles that of Connecticut and of Nova Scotia, and is a fine-grained Dolerite.

3. *Drift Deposits.*

I do not propose in this Report to enter minutely into these, as their consideration is of scientific rather than of practical importance, but may state a few of the leading facts.

1. The lower member of the drift deposits in Prince Edward Island is a "boulder-clay," often of considerable thickness and containing great numbers of more or less rounded fragments of the Triassic sandstone. These are very often striated or grooved in the direction of their longer axis in the manner now so well known to result from the action of ice. Very few rocks transported from a distance occur in this boulder-clay, except in the western part of the Island, where boulders derived from the metamorphic regions of Nova Scotia and New Brunswick were observed to be frequent. The boulder clay rests in many places on striated rock surfaces, but the softness of the rock generally prevents them from being observed. In the few places where they could be detected, they presented two distinct directions, viz. N. E. and S. W., and N. W. and S. E., which are prevalent directions of such striation in other parts of Eastern America. This boulder clay is very generally distributed over the surface of the Island, forming the subsoil; but, as the

boulders themselves are soft and easily disintegrated and the intervening material is a fertile clay or loam, this deposit is in no way injurious to the fertility of the country.

2. In some parts of the Island, especially in the west, are beds of stratified sand and gravel with occasional boulders, resting on the boulder clay. These beds manifestly indicate the action of the sea, and in one of them, at Campbellton, we were shown by Mr. D. Bell, shells of *Tellina Groenlandica*, a modern marine species, in one of these beds. Near Cape Bear the upper part of the drift was observed to be full of small pieces of gray carboniferous sandstone.

Lastly, there are scattered over the soil, though usually not in great numbers, loose stones or boulders, many of which are of the native rocks of the Island, but many also have been derived from other sources. Eastward of Charlottetown, in the region near Northumberland strait, the most common travelled boulders are granite, quartzite, &c., from Nova Scotia; but on the north side, between St. Peters and East Cape, the boulders, which are more numerous, are chiefly Laurentian rocks, which must have been derived from Labrador or Newfoundland. On the western part of the Island more numerous boulders occur, derived from both the above sources. In the later portion of the boulder or glacial period, Prince Edward Island would seem to have been a meeting place of ice-laden currents carrying boulders from both sides of the Gulf of St. Lawrence. It is to be observed that in some places the denudation of the boulder clay has left numbers of boulders on the surface; but in this case it will be found that these are mostly of the native red sandstones. The travelled boulders belong for the most part to a subsequent deposit.

The travelled boulders and the quartz pebbles of the Triassic conglomerate seem, from the specimens which I procured, to have furnished the aborigines of the Island with the material of their stone implements.

On the north coast, east of St. Peters, Laurentian stones and pebbles abound on the shore, and they are said to be annually thrown up by the waves; but whether this arises from modern ice transport from Labrador, or from the action of the sea on stones deposited in a submarine drift, is uncertain.

The history of these Post-pliocene deposits may be summed up as follows:

1. In the early part of the Post-pliocene—the "Glacial period" of Geologists—the Island was submerged and was ground over by icebergs, at a time when the high land which produced these icebergs was so completely covered by ice and snow that it could furnish few boulders. At this time the lower boulder clay was produced. Extreme Glacialists would, however, hold that Prince Edward Island itself was at this time under a continental glacier.

2. In the later Post-pliocene, the Island, still under water, was annually visited by floating ice carrying stones. Some of this drifted under the influence of the Arctic current from Labrador, but a larger quantity was brought by the tidal currents from the south. That part of Prince Edward Island opposite the wide channel between the hills of Nova Scotia and New Brunswick, now occupied in part by the Bay of Fundy, was of course most exposed to these currents, and, consequently, most abounds in boulders.

3. The stratified sands and gravels were formed when the land was emerging from the waters.

4. Since the last emergence there has been a slight subsidence.

4. *Modern Deposits.*

(1.) *Peat.*

Peat bogs occur in many parts of the Island, but are usually of small extent and depth. A remarkable exception to this occurs in the great turbary known as the Black Bank on the south side of Cascumpeque Bay, and in some other bogs in Richmond Bay and its vicinity. These were particularly examined by Dr. Harrington, whose report I give in full, as the subject is of some economic importance :

The deposits more particularly examined, as being apparently the most important, were :

1st. That on the northern shore of Lennox or Indian Island in Richmond Bay ;

2nd. That at Squirrel Creek, adjoining the property of the Hon. William H. Pope, near the same bay ;

3rd. The deposit at Cascumpeque known as the "Black Bank."

(1.) *Lennox or Indian Island* :—The deposit here is not so extensive as the other two, but still is worthy of notice ; it occurs on the north-east shore of the Island, and must once have been of far greater extent that at the present day.

The peat is almost entirely the result of the accumulation of a species of *Sphagnum* or "peat moss" which has the property of decaying below and giving forth new vegetation above. Most of it belongs to the class called by Karmarsch, "turfy peat" (Rasentorf), that is to say it consists of masses which are but slightly decomposed, has a yellow or yellowish brown colour and is soft, spongy and elastic ; but the lower portion of the bed is what is known as "fibrous peat" which is characterized by its brown or black colour, by a much greater density than the turfy, by its small degree of elasticity, and by the fact that the fibres, although distinguishable by the eye, are much more readily broken up than turfy peat.

It was roughly estimated to cover a surface of 250,000 sq. yds., and has a depth of about 7 feet, which makes the contents amount to nearly 600,000 cub. yds. (583,333). Now peat, by ordinary drying, shrinks so as to occupy only $\frac{1}{3}$ or even $\frac{1}{5}$ of its original bulk, and, when the fibre is broken up by hand or machinery, it may shrink so as to occupy even as little as $\frac{1}{8}$ of its original bulk. Allowing it to lose $\frac{4}{5}$ in drying, 120,000 cub. yds. of dry peat would be the result; or, taking the average specific gravity at 0.2, about 20,200 tons.

The bank is constantly being washed away by the waves, and at high tide the water comes to within 3 feet of the top. At low-water mark there are numerous roots and a few old stumps of trees which were very likely killed by the growth of the Sphagnum.

(2.) *Squirrel Creek.*—The peat at this place is of rather better quality than the last described, being for the most part "riper;" but, like most peat bogs, the lower portion is much denser and darker coloured than the upper. As at Lennox Island it belongs to the two classes known as "turfy" and "fibrous peat."

The deposit here is what would be called in Germany a "high moor" (Hochmoor) from the fact of its having grown to a greater height at the centre than around the borders. This usually takes place if the growth is of moss, while, if the vegetation has consisted of grasses or sedges, the bed is likely to be flat or hollow in the centre and is known as a meadow-moor, (Wiesenmoor).

The depth was tried in many places by means of a long iron rod, and found to be not more than 4 feet around the borders, but, on going towards the interior, it gradually deepened, until it attained a thickness of 11 or 12 feet, so that 9 feet probably represents pretty closely the average depth.

It was said to have an area of 800 acres, but the area of workable peat is probably not more than 500 acres. Assuming this as the area, and taking the average depth as given above at 9 ft., we get 7,260,000 cub. yds. as the content; or, deducting $\frac{4}{5}$ for loss in drying, 1,452,000 cub. yards or (taking the sp. gr. at 0.40) about 500,000 (488,743) tons of air-dried peat.

The highest portion of the bog was much wetter than the lower part around the border, and here and there were little ponds containing water plants. The bottom of the ponds could not be reached with a rod more than 12 feet long.

This bog like the others is entirely destitute of trees, but is covered with a number of small plants; and, among others, several species of *Vaccinium*, *Pogonia ophioglossoides*, *Calopogon pulchellus*, *Rubus chamaemorus*,

Juniperus communis, a species of cotton-grass or *Eriophorum* (probably *Virginicum*.)

(3.) *Black Bank, Cascumpeque.*—This deposit is situated on the southern side of Holland or Cascumpeque Bay, its eastern limit being over a mile from what is known as "Cascumpeque Narrows." This is the most extensive deposit seen, and the peat is also of the best quality. Owing to its very black colour it has received the name of Black Bank or "Black Point." At the water's edge it is quite perpendicular, and is constantly being undermined and washed away. The height of this bank at the extremity of the Point is 12 feet or a little over, and yet, during storms, the waves come dashing in over the sandbank opposite and reach its very top. On going inward from the shore it rises towards the centre 7 or 8 feet higher, being like the last described a "highmoor" (Hochmoor). The average thickness was estimated at 15 feet, and the Sphagnum is still growing over a large part of the bog. The area was estimated at nearly three million square yards (2,816,000) which would make the cubical content amount to 14,080,000 cubic yards.

The peat is much denser and of a darker colour than that either at Squirrel Creek or Lennox Island, the lower half being very dark brown, or quite black, and much of it having nearly lost its fibrous structure ; in this it approaches the character of what is known in Germany as "earthy peat."

Assuming it to lose ¾ of its bulk in drying, this bog would afford 3,520,000 cubic yards of dry peat, or, taking the sp. gr. at 0.60, 1,777,248 tons.

Coming out from beneath the peat, and a little below low water mark, are to be seen numerous roots of trees in a perfect state of preservation, and about 6 feet above this there occurs another layer of small roots, which could however only have belonged to shrubs or very small trees. Besides these, small rootlets, probably of shrubs, are to be seen scattered here and there throughout the mass. The occurrence of stumps and roots so low down both here and at Lennox Island leads to one of two conclusions, either (1) there has been a subsidence of the Island, amounting to several feet, since the time when the trees were growing, or (2) a large portion of the coast has been washed away. In the latter case the trees must have been growing in a hollow below the sea level.

The deposits at Indian (Lennox) Island and Cascumpeque, must at some time have been of far greater extent than at the present, as in both cases they are cut off where the peat has a considerable thickness. This decrease in size would of course be the result of subsidence of the land ; for the waves, being once admitted, wash away the peat very rapidly.

Directly west of "Black Bank" there is said to be a second deposit

exceeding it in magnitude; this could be seen from "Black Point," but darkness coming we were obliged to leave and could not again visit the place. Still another deposit is said to occur on Grover Island in Richmond Bay, the extent of which we do not know.

Estimates of the extent of bogs must, of necessity, be merely approximations where no exact measurements are made, since one is exceedingly liable to make wrong estimates of distances on a treeless waste. Such approximations are, however, of value, and we trust that those given here may not be very far from the truth.

The modern subsidence of the land indicated by this bog is not without additional illustrations elsewhere. At Gallas Point and other places in Orwell Bay, stumps of trees are seen on the edges of the marshes apparently rooted in situ, and are five feet below high water mark. Such modern subsidence seems to have occurred in many parts of the American coast, and in Nova Scotia there are evidences of it on a more extensive scale than in Prince Edward Island.*

(2.) *Oyster Beds, or "Mussel Mud."*

The common American oyster, *Ostrea Virginiana* and *var. Borealis*, occurs abundantly on the coast, and large accumulations of its shells with those of the Mussel, *Mytilus edulis*, have been formed in some of the bays and river estuaries. I was informed by Mr. W. H. Pope, who has given much attention to this subject, that some of these beds are fifteen feet or more in thickness. They consist of dead shells, and in many places no living shells occur even at the surface, the animals having been killed by the gradual approach of the beds to the surface of the water, exposing them to the action of the frost and ice and to invasion of sandy sediment. These beds of dead oyster and mussel shells, with the mud filling the interstices, constitute one of the most valuable deposits on the Island. Under the name of "Mussel Mud" this material is taken up in great quantity by ingenious dredging machines, worked from rafts in summer or from the ice in winter, and is applied as a manure to the soil with the most excellent effects. It supplies lime and organic matter, besides small quantities of phosphates and alkalies.

The shells in these old beds are all of the long narrow form (*O. Virginiana*), and Mr. Pope informs me that the round form (*O. borealis*), occurs at the surface in many places where the long narrow form is found only a few inches below. It also appears that the modern oysters procured in the upper parts of the rivers and on muddy bottom tend to the long form, while those in more salt water and on hard bottom are round.

* Acadian Geology, p. 28.

(3.) *Sand-Hills or Dunes.*

These mounds of drifted sand are extensively developed along the outer or north-west shore, where they extend in long lines across the bays and parallel to the coast. In all they extend in length about 45 miles, and are sometimes more than 40 feet high. Though usually held together by the roots of coarse grasses, they are liable to frequent changes, which are much promoted by the cropping of the grass by the cattle or by any artificial or accidental breaking of the surface. At St. Peter's I saw an old entrance used in the early French times, quite filled up with the blown sand, and I was told that a hill, forty feet high, had been removed within a few years, and had disclosed the remains of an old blacksmith's forge under its base. The sand in these hills is derived from the waste of the red sandstones; and, when left dry by the tide, is blown up by the wind. The attrition to which it has been subjected has removed the coating of red oxide of iron from the siliceous grains of sand, so that, though derived from red rocks, these sands are nearly white. Where the sand-hills run along the coast, a long narrow channel often occurs between them and the shore, and they often block up streams, forming lagoons, in which deposits very different from those of the open gulf are produced.

(4.) *Shore Ridges.*

Mr. Pope kindly pointed out to us on a creek near Grand River, and on Ives Creek, the mounds known locally as "shooting dykes," in allusion to their use by sportsmen as a shelter in duck-shooting. These are somewhat regular banks or dykes of soil fringing the creeks, and having almost the appearance of artificial earth-works, which they have indeed been supposed to be. Some of them are six feet in height and ten feet wide at base. I believe them to be of the same nature with the Lake Ridges of Nova Scotia described in my Acadian Geology,* and that they have been produced by the expansion or driftage of the ice, which forms in the creeks in winter. They constitute a sort of "Moraine" deposit, which, on a larger scale and in a more hilly country, might readily be mistaken for the work of glaciers. Those that we saw were entirely composed of soil intermixed with vegetable matter. Some of them showed evidence of formation by successive increments of material. Their steepest sides were next the land, and they were highest opposite the most exposed and widest portions of the creeks.

* P. 35.

II. RELATIONS TO THE COAL FIELDS OF NOVA SCOTIA AND NEW BRUNSWICK.

THE facts stated under the previous general heading, afford the data for an answer to this question as complete perhaps as can be obtained without actual mining operations.

The Carboniferous rocks of Nova Scotia consist of the following members in descending order: *

The Upper Coal Formation, consisting of red and gray sandstones with thin beds of coal, not as yet worked 1500 to 3000 feet.

The Middle Coal Formation, consisting of sandstones, shales, &c., usually of gray colours, and containing the large productive beds of coal, estimated at about 4000 feet.

The Millstone Grit Series, consisting of sandstones and conglomerates without productive coal, 5000 to 6000 feet.

The Lower Carboniferous Marine Series, containing limestones and gypsum, with sandstones, shales and marls. Thickness very variable.

The Lower Carboniferous Coal-measures, consisting of sandstones, shales and conglomerates without productive coals, but with highly bituminous shales.

In Nova Scotia these beds are tilted up, often at considerable angles and the upper portions of them have been removed by denudation in such a manner that the edges of the coal-beds appear at the surface, and can be opened up without penetrating the overlying beds. In Prince Edward Island the case is different, the beds being very nearly horizontal; so that only the upper members can be seen, and these are in many places covered with the Triassic series.

The places explored by us in which the coal-measures are nearest the surface, are Governor's Island and Gallas Point, and the coast extending from West Cape to North Cape. To these may perhaps be added the coast near the Wood Islands, where it is probable that the Carboniferous rocks may be covered with only a very limited thickness of Trias.

If boring were undertaken at either of the above places, it might be hoped that the upper coals would be reached at a depth of not less than 500 or more than 2000 feet. Should these prove too thin to be worked, there would be little hope of reaching the lower coals at a less depth than 3000 or 5000 feet, which would, of course, be a depth altogether too great for profitable working at present.

The above estimate proceeds on the supposition that the coal-measures underlying Prince Edward Island are similar to those of Nova Scotia. It

* See for more full description, Acadian Geology, pp. 1-8, &c

is to be observed, however, that in New Brunswick there is reason to believe that the aggregate thickness of the Carboniferous rocks is much less, but unfortunately the beds of coal partake in this diminution of thickness. Should the coal rocks under Prince Edward Island, therefore, prove similar to those of New Brunswick, they would be found at a less depth, but on the other hand might be of less value.

As the beds exposed at Miminigash are in the line of the Buctouche anticlinal, on the coast of New Brunswick, and those of Gallas Point and Governor's Island are in the line of the Cape Tormentin anticlinal in the same province, and, as the beds have much the aspect of the Upper Carboniferous in New Brunswick, it might be inferred that the coals under these places may resemble those of New Brunswick. In that province no beds of coal of greater thickness than two feet are known. At Wood Islands the beds reached might be supposed to resemble more those of the northern part of Pictou District, in which no coals thicker than three feet are yet known in the Upper Coal-formation; and the great beds of the Middle Coal-formation would probably at this place be too deep to be profitably worked.

On the other hand, it is possible, though there is no evidence of this, that the coal of the Upper Coal-formation under Prince Edward Island, might be more abundant than in the districts mentioned, and it is to be observed that those districts cannot be considered so fully explored as to render important new discoveries improbable. From these statements the general practical conclusions would be,—

1. That Carboniferous rocks, similar to those of Nova Scotia or New Brunswick, probably underlie the whole of Prince Edward Island.

2. That, in certain places indicated above, the upper member of the Carboniferous Series appears at the surface in a nearly horizontal and undisturbed condition.

3. That boring operations prosecuted at these places would, undoubtedly, reach the Upper and possibly the Midd e coal-measures, and the beds of coal which they may contain.

4. That the productive value of such coals must be uncertain previous to such actual trial.

5. That the depth of the seams would probably be too great for profitable mining in the present state of the coal trade.

The greatest depth at which coal is at present mined in Nova Scotia is about 900 feet,* and the greatest depth in England is 2000 feet. No mines in Nova Scotia or New Brunswick, have as yet penetrated the Upper coal-measures in search of coal, nor have such careful and minute

* Foord Pit at Albion Mines, Pictou.

surveys of these beds been undertaken as would supersede the necessity of boring operations in Prince Edward Island, should it be desired to test the point practically. Should any operations of this kind be undertaken and prosecuted to completion on the mainland, the information there obtained could readily be applied to Prince Edward Island. On the other hand, the successful penetration of the newer coal-formation in Prince Edward Island, in search of coal, would at once develop the corresponding regions of the mainland now untried. In any case, deep boring in the newer coal-formation, either in northern New Brunswick or in Prince Edward Island, could scarcely fail to develop facts of scientific interest.

In event of such boring being undertaken to a moderate depth, the methods now in use in Nova Scotia, and in the oil districts of Canada and Pennsylvania would be sufficient; but if it were intended to penetrate to great depths, some of the improved methods which have been applied to deep boring in Europe would be preferable.

On the whole, it may be concluded that the probabilities are decidedly against the discovery of a large bed of coal at such a depth as to enable it to be immediately available.

The map and ideal section accompanying this Report will serve to represent to the eye the points above stated.

With the view of comparing the formations seen in Prince Edward Island with those on the mainland of New Brunswick, I crossed from Summerside to Shediac, and examined some parts of the coast between that place and Jourimain Island, near Cape Tormentin, where rocks similar to those of Prince Edward Island had been reported by Professor Robb to occur. At Cape Bald I found some of the upper beds of the Carboniferous well exposed. They consisted of coarse brown and gray grit irregularly bedded and nearly horizontal, or with a very slight dip to the west. They contained numerous specimens of *Calamites Suckovii* and of a large *Calamodendron*. Similar beds appeared in the marsh connecting Cape Jourimain with the mainland, but on the outer side of the Island the rocks were bright red, and by no means unlike in mineral character those on the opposite shore of Cape Traverse.

In ascending order, they consisted of red, concretionary and calcareous sandstone, with greenish stains and irregular fucoidal stems; flaggy, micaceous, red sandstone, with green stains and thin white bands, and reddish concretionary limestone; red and mottled arenaceous shale; irregularly bedded soft red sandstone, with bands of mottled shale. These beds were nearly horizontal, or with only a slight dip to the east and north-east. The only fossil found was a fragment of silicified wood, but whether

this had been derived from the red beds or from the underlying brown sandstone, I do not know. On the whole, I regard these beds at Cape Jourimain as probably an outlier of the Lower Trias. There are, however, on other parts of this coast, and more especially between Cape John and Pictou, beds included in the Carboniferous which are scarcely distinguishable, except by their fossils, from these beds at Cape Jourimain. On a visit to Pictou, I re-examined some of these beds with the view of satisfying myself as to this resemblance.

III. ECONOMIC GEOLOGY AND ANALYSES OF MINERALS.

1. *Peat as Fuel.*—The question of fuel is likely, from the rapid disappearance of the forests, to be a matter of extreme importance in Prince Edward Island. The cheapness of coal in Nova Scotia, along with the easy transport by water to most parts of the Island, and the convenient inland transportation which will be afforded by the railway now in progress, must prevent any serious difficulty; but it is worthy of consideration whether measures should not be taken by the Government for the protection of the remainder of the forests, and whether the time has not come for the utilization of the large deposits of peat existing in some parts of the Province.

In European countries, and more recently in Canada and the United States, peat has commanded much attention as a cheap and convenient fuel. In its natural state, or merely air-dried, it has been much employed for local consumption, though of very inferior heating power to coal; but when pulped or compressed and thoroughly dried, it has been found capable of competing with coal and wood on equal terms both for steam production and domestic use. Charred peat has also become an important article of consumption as a substitute for wood charcoal and coke. The importance of this subject may be inferred from the fol'owing calculations by Dr. Harrington as to the quantity of peat in the three great turbaries noticed under a previous heading:—

Lennox Island Bog,	20,200	tons, value, at $4	....	$ 80,800.00
Squirrel Creek "	500,000	" " " "	....	2,000,000.00
Black Bank "	1,777,248	" " " "	....	7,108,992.00
	2,297,448	" " " "	....	$9,189,792.00

Dr. Harrington has made comparative trials of the peat with that in use in Canada, with the results stated below, which show that the quality, in the case of the largest of the three deposits, is excellent; and, as the facilities for its extraction and shipment, especially at the Black Bank, are all that

could be desired, there can be no doubt that the three deposits above, without mentioning others, are capable of supplying a very large quantity of good fuel.

That deserving of attention, in the first instance, is undoubtedly the Black Bank at Cascumpeque, both on account of the readiness of access to it and its good quality. It is also to be observed that another deposit exists in Cascumpeque Bay, and is said to be of great extent, though we had not an opportunity to examine it or to obtain specimens for analysis.

(2.) *Building Stone.*—The ordinary red sandstone of the Island, where thick-bedded and uniform in hardness, affords a fair building stone, easily cut when recent and becoming harder on exposure. Walls and buildings constructed of it were seen in several places, and seemed to have proved sufficiently durable. When furnished with corners, &c., of gray stone, it has a good appearance. Stone of this kind can be obtained in nearly all parts of the eastern and middle sections of the Island and in some parts of the western section; but that which has been wet with sea water should be avoided as likely to crumble.

The best exposure observed of this stone is that on the farm of Mr. Ault, on the Bannockburn road, about one mile from the Wiltstone road. At this place the rock occurs, without any cover, on the summit of a ridge, and dipping at a small angle N. 60° E. The upper part is a good gray sandstone, rather coarse in texture, but of good colour. It has been used in Charlottetown. This bed as exposed seemed to be about three feet thick. Below was a deep red sandstone also apparently of good quality, of this from 10 to 20 feet were seen. The same beds have been quarried to the south of this place at the West River. The exposure at Bannockburn is about four miles from the line surveyed for the railroad, and as the ridge runs in that direction, it is quite possible that quarries may be opened much nearer to the line, and may furnish a valuable supply of stone to Charlottetown.

The hard calcareous bands occurring in the red sandstones afford a very durable stone for foundations and other rough masonry.

The brown sandstones of Gallas Point and the coast near Campbellton have a different appearance from the red beds of the Trias, and are of somewhat greater hardness. They are deserving of trial as building stone.

(3.) *Brick Clay, &c.*—Excellent deposits of this material abound on the Island. They are of three kinds—(1) The beds of red clay interstratified in the Triassic formation. These are very pure and free from stones, but require to be quarried and exposed to the action of the frost and mixed with sand. (2) Post-pliocene clays belonging to the boulder

formation. These are often stony, but otherwise good material. (3) Modern alluvial clays which have accummulated in the lower levels from the waste of the higher grounds. The last are those chiefly worked at present, but the others will eventually be more largely used. I may add here, that should the process now extensively used in the United States and Great Britain for the manufacture of artificial stone from sand, come into use in the Island, the immense supplies of fine and uniform sand contained in the sand hills of the north shore will afford an inexhaustible supply of the best possible material.

(4.) *Limestone.*—This occurs both in the Upper Carboniferous and the Trias, but not in thick beds, or of pure quality. The best limestone observed was that at Miminigash and its vicinity. It is in large concretions of hard, earthy limestone, in a bed of marly sandstone about three feet thick. Similar beds, but apparently of less importance, occur at Gallas Point and Governor's Island.

In the Trias thin bands of concretionary limestone and conglomerate limestone were observed in several places, more especially in the vicinity of Richmond and Bedeque Bays, at Indian River and at Kildare. These beds are all of coarse quality, and some of them are Dolomitic, or contain carbonate of magnesia. They are used for agricultural purposes, and where so situated as to be easily quarried, may afford a cheaper lime for this purpose than that which is imported. We were informed that at Freetown, near Bedeque Bay, this limestone is burned on a somewhat large scale.

(5.) *Metallic Ores*—were not observed anywhere in sufficient quantity to be of economic importance. The principal are :—

Red Hematite.—An excellent ore of iron, in concretions at Gallas Point and elsewhere. At Gallas Point sufficient quantities may be picked up on the beach to afford a small additional supply to an iron furnace, but not to warrant any independent enterprise.

Gray Sulphide of Copper.—In concretions in a sandstone at Governor's Island, associated with green carbonate of copper.

Bog Manganese Ore and Bog Iron Ore—In concretions in many swamps in different parts of the Island, but not in quantity to render it of any importance.

(6.) *Water.*—The fissures of the red sandstone afford in many places copious springs of excellent water, and this suggests the possibility of obtaining additional supplies by boring. As the supply of water to Charlottetown is at present very deficient, it is deserving of consideration whether this means might not be advantageously used to increase it. The stratigraphical arrangement of the rocks in the vicinity of the city is favourable to

success, and borings of moderate depth, such as would be necessary to test the quantity which could be obtained, are executed in Nova Scotia at about \$1 to \$2 per foot, so that the expense would be small, and supplies of water of great importance to the comfort and health of the citizens might be obtained.

(7.) *Soils.*—The great wealth of Prince Edward Island consists in its fertile soil, and the preservation of this in a productive state is an object of imperative importance. The ordinary soil of the Island is a bright red loam, passing into a stiff clay on the one hand, and sandy loam on the other. Naturally it contains all the mineral requisites for cultivated crops, while its abounding in peroxide of iron enables it rapidly to digest organic manures, and also to retain well their ammoniacal products.

The chief natural manures afforded by the Island, and which may be used, in addition to the farm manures, to increase the fertility of the soil, or restore it when exhausted, are :—

1. The mussel mud, or oyster shell mud of the bays. Experience has proved this to be of the greatest value.*

2. Peat and marsh mud and swamp soil. These afford organic matters to the run out soil at a very cheap rate.

3. Sea weed, which can be obtained in large quantities on many parts of the shores, and is of great manurial value, whether fresh or composted.

4. Fish offal.—The heads and bones of cod are more especially of much practical importance, and should be more carefully preserved than at present.

5. Limestone.—The brown earthy limestones of the Island are of much value in affording a supply of this material as well as small quantities of phosphates and alkalies.

Where manures require to be purchased from abroad, those that will be found to produce the greatest effects are such as afford phosphates and alkalies, more especially bone earth, superphosphate of lime and guano; but where fish offal and sea weed can be procured in sufficient quantity, or good dressings of the oyster deposit are applied, these foreign aids may well be dispensed with, at least for many years.

SPECIAL REPORT BY DR. HARRINGTON ON THE CHEMICAL COMPOSITION OF PEAT, LIMESTONE AND COPPER ORE.

(1.) *Peat.*

The peat deposits of Prince Edward Island have already been described but nothing could be said with certainty concerning their quality until

* Mr. J. W. Taylor, F.G.S., has, I believe, made several analyses of this manure, and is about to publish his results; which, I have no doubt, will be of much value.

assays had been made. Accordingly, at the request of Principal Dawson I have determined the percentages of water, volatile combustible matter, fixed carbon and ash in several specimens, and, by way of instituting a comparison between the Canadian peats and those of Prince Edward Island, have examined two varieties, known in Montreal as "Hodge's peat" and "Champlain peat."

The latter is simply cut and air-dried; Hodge's is also air-dried, but is first pulped.

Two assays of the Champlain peat gave the following results:—

	1.	2.	Mean.
Water (hygroscopic)	14.82	15.10	14.96
Volatile combustible matter	60.10	59.10	59.60
Fixed carbon	21.80	22.60	22.20
Ash	3.28	3.20	3.24
	100.00	100.00	100.00

The value of peat as a fuel must necessarily be greater according as the amount of fixed carbon (coke) increases, and the proportions of water and ash decrease. The percentage of hygroscopic water varies according to the time of seasoning and the method of drying employed, but air-dried peat, like wood, rarely contains less than about 15 per cent.

The samples of Champlain peat show a minimum in this respect, but they had been drying within doors for a year.

One of the disadvantages which peat, as a fuel, has to contend with, is the large amount of mineral matter or ash which it contains. This usually runs from 5 to 10 per cent., sometimes being lower than 5 and often higher than 10 per cent. Many peats, however, which contain as high as 10 per cent. may, nevertheless, be excellent fuels if their content of carbon is large. Wood usually contains only 0.50 to 1.50 per cent.

In the Champlain peat the amount of ash is small (2.24 per cent.), but the per centage of fixed carbon (22.20) is lower than that found in the other peats assayed, with one exception.

The following are two assays of Hodge's peat which had been kept within doors for a year:—

	1.	2.	Mean.
Hygroscopic water	16.80	17.32	17.060
Volatile combustible matter	49.80	51.65	50.725
Fixed carbon	26.90	25.00	25.95
Ash	6.50	6.03	6.265
	100.00	100.00	100.00

This is a better quality of peat than the last, notwithstanding that the amounts of water and ash are rather larger.

The Prince Edward Island peat which was examined, had been drying for about three weeks in a dry room.

The first assayed was that from Indian (Lennox) Island, and which, on account of its large percentage of ash, must be considered of inferior quality.

The assays are as follows:—

	1.	2.	Mean.
Hygroscopic water	23.53	23.89	23.710
Volatile combustible matter	41.39	41.00	41.195
Fixed carbon	19.74	19 93	19.835
Ash	15.34	15.18	15.260
	100.00	100.00	100.00

Assays were likewise made of peat from Black Bank, the results showing, as might be expected, that the lower and riper half of the deposit is richer than the upper half.

The following are the assays:—

1. *Upper Half.*

	1.	2.	Mean.
Hygroscopic water	16.34	16.70	16.52
Volatile combustible matter	53.50	53.08	53.29
Fixed carbon	22.26	22.70	22 48
Ash	7.90	7.52	7.71
	100.00	100 00	100.00

2. *Lower Half.*

	1.	2.	Mean.
Hygroscopic water	15.02	14.64	14.83
Volatile combustible matter	50.00	50.30	50.15
Fixed carbon	28.10	28.26	28.18
Ash	6.88	6.80	6.84
	100.00	100.00	100.00

The last, then, is an excellent peat, and, while the percentage of ash is not very high, the amount of fixed carbon is greater than in any of the other peats assayed.

In order to facilitate comparison the following table has been prepared :

LOCALITY, &C.	HYGROSCOPIC WATER.	VOL. COMBUST. MATTER.	FIXED CARBON.	ASH.
Champlain Peat	14.82	60.10	21.80	3.28
" "	15.10	59.10	22.60	3.20
Mean of above	14.96	59.60	22.20	3.24
Hodge's Peat	16.80	49.80	26.90	6.50
" "	17.32	51.65	25.00	6.03
Mean	17.06	50.725	25.95	6.265
Indian Island	23.53	41.89	19.74	15.34
" "	23.89	41.00	19.93	15.18
Mean	23.710	41.195	19.835	15.260
Black Bank. U. Half	16.34	53.50	22.26	7.90
" " " "	16.70	53.08	22.70	7.52
Mean	16.52	53.29	22.48	7.71
Black Bank, L. Half	15.02	50.00	28.10	6.88
" " " "	14.64	50.30	28.26	6.80
Mean	14.83	50.15	28.18	6.84

The assay of the Peat of Squirrel Creek, referred to in the General Report, is not included in the above, owing to the samples not having come to hand ; but it is hoped that they may be received in time to include them in the printed report.

A few remarks upon the employment of peat as fuel, and for agricultural purposes, may not be out of place here.

One of the principal difficulties in the way of its preparation for fuel is the large amount of water which it contains before being dried. In Ireland it has been found that this amounts to from 92 to 95 per cent. for the undrained peat, while the parts more or less drained contain from 88 to 91 per cent. From these facts it has been estimated by Dr. Hunt that in cutting and removing the peat from the bog about 9 tons of water have to be transported for every ton of fuel. Where labour is high this is, of course, an important item, and peat should always be prepared and dried as near to the spot where it is cut as possible, in order to avoid the carrying of so much water.

It may be asked whether, bulk for bulk, air-dried peat possesses the same heating power as wood. The following table by Brix, cited by

Prof. Johnson, in his work on peat, shows that its heating power is at least not nearly as great as that of oak wood:—

	Weight per cord.	Heating effect.
Oakwood	4150 lbs.	100
Peat from Linum, 1st quality	3400 "	70
" " " 2nd "	2900 "	55
" " " 3rd "	2270 "	53
Peat from Buechsenfeld, very dense	3400 "	74
" " " 2nd quality	2730 "	64

While, however, bulk for bulk, the heating power may be less, weight for weight there is no great difference, and this in favour of the peat.

The following table has been prepared by Professor Johnson, of Yale College, to show the heating power of different kinds of fuel:—

	Units	of	Heat.
Air-dry wood	.. ..	2800	......
" " peat	2500	......	3000
Perfectly dry wood	......	3600	......
" " peat	3000	......	4000
Air-dry lignite or brown coal	3300	......	4200
Perfectly dry lignite or brown coal	4000	......	5000
Bituminous coal	3800	......	7000
Anthracite	......	7500	......
Wood charcoal	6300	......	7500
Coke	6500	......	7600

It must, however, be borne in mind that peat may be condensed, so that, even bulk for bulk, its heating power will be greater than that of wood.

The disadvantages which peat, as a fuel, has to contend with, may be summed up as follows:—(1) The large amount of water which it contains as found in the bog, necessitating a great deal of labour before it can be fitted for burning. (2) The quantity of water which it contains after drying, and which, in being evaporated, consumes a large amount of the heat which might be otherwise utilized. Gysser found that peat which had been condensed and hot-dried, and retained but ten per cent. of water, possessed about half as much again heating power as air-dried peat retaining twenty-five per cent. of water. (3) The large bulk which it occupies unless condensed, and which makes transportation and storage expensive. It has been estimated that the space occupied by the peat necessary to produce a given amount of heat is about 5½ times as great as that occupied by the quantity of anthracite necessary to produce the same amount of heat. (4) The large percentage of ash, as compared with that of wood, which it frequently contains; this disadvantage, however, it shares with a large number of mineral fuels.

Notwithstanding all these difficulties, the employment of peat as fuel is increasing, and this increase will probably be greater in proportion as the price of other fuel is raised. For the purpose of generating steam, more especially on locomotives, it has proved itself to be most valuable, both

abroad and in this country, and the Montreal Peat Company at present manufacture exclusively for the Grand Trunk.

In countries where mineral coals are scarce, as in Sweden and parts of Germany and France, it has been quite extensively used in the manufacture of iron, in which case it is very often first converted into charcoal. Moreover, the charcoal or coke made from many varieties of peat is considered as better than that made from wood.

The yield of charcoal ranges from twenty-five to thirty-five per cent. of the peat by weight, and thirty to fifty per cent. by volume. (Johnson.)

For domestic purposes peat has proved itself to be an economical fuel, even when simply cut and air-dried, but this more especially for farmers whose supplies of firewood have run out, and who have peat bogs on or at no great distance from their farms.

When, however, it is to be transported to any distance, it is best to make use of some one of the various methods for compressing or artificially drying it, by which means, as already mentioned, the bulk is greatly reduced and the heating power increased. Care should, however, be taken in the selection of a method, as some of these, while producing an excellent fuel, have been found to be altogether too expensive. Hodge's method of pulping and drying has so far been successful in Canada, and produces a hard compact fuel.

The farmers living in the vicinity of Black Bank or Squirrel Creek, might easily avail themselves of the large quantity of fuel contained in these deposits. I should, however, especially recommend trying the peat of Black Bank on the locomotives of the projected railroad. The peat could be cut at Black Bank, prepared according to Hodge's or some other equally good plan, and then taken by water, either to the terminus of the railway at Cascumpeque Point, or up Foxley and Trout Rivers.

For water transport, it would probably be best to employ flat-bottomed scows towed by a small tug. Once at the railroad, it could be taken from one end of the Island to the other, and by taking the proper precautions, would probably prove the cheapest fuel for use on the locomotives.

Upon the use of peat in agriculture we cannot enlarge here, but its importance as a manure is well known. It loosens up the soil, and on account of its great power of retaining moisture, is of the greatest benefit in dry regions. Moreover, it contains in itself many elements which constitute, or may be readily made to constitute the food of plants; thus, carbon by its oxydation forms carbonic acid, which is absorbed largely by the roots and leaves of plants.

All peats have been found to contain nitrogen, which is an essential ingredient of almost all valuable manures. This nitrogen, by the action

of the air, becomes converted into nitric acid and ammonia, which are the forms under which it is available to the plant.

The mineral portions, too, consist of substances many of which form portions of the food of plants; among other things are found potash, soda, lime, oxyd of iron and phosphoric acid, all of which are of very great importance to the plant.

(2.) *Limestones.*

In order to understand more fully the character of the P. E. I. limestones and their adaptibility for agricultural and building purposes, several partial analyses have been made, the results of which will be given below.

The localities from which the samples for analysis were taken are Miminigash, Cape Kildare, Gallas Point (two varieties), and New London.

The limestones are all impure, and all contain carbonate of magnesia, the percentage of the latter, however, being in general small. The sample from Kildare differs from the others in that it contains nearly 23.00 per cent.; that from Miminigash comes next to it, containing 3½ per cent.

The Miminigash limestone contains a smaller proportion of insoluble constituents than the other samples, and a much larger proportion of carbonate of lime, the amount of the latter being 78.07 per cent. The light gray limestone of Gallas Point comes next to the Miminigash in regard to its content of carbonate of lime, the percentage being 59.71.

The process of analysis employed consisted in treating the limestone with hydrochloric acid, filtering off the insoluble residue, throwing down the iron and soluble alumina with ammonia, afterwards precipitating the lime as carbonate or oxalate, and lastly, the magnesia as phosphate.

Below is given a table of the analyses, two having been made of each sample.

LOCALITY, &c.	CARBONATE OF LIME.	CARBONATE OF MAGNESIA.	ALUMINA (SOLUBLE) AND PEROXYD OF IRON.	INSOLUBLE RESIDUE.	WATER AND LOSS.
Miminigash,	77 52	3.28	2 41	15.45	1.34
"	78.63	3 74	2.77	15 54	....
Mean	78.07	3.51	2.69	15.49	0.24
Kildare (Dolomite)	45.03	22.60	3 55	25.04	3 78
" "	44.00	22.93	3 73	26.59	2.75
Mean.... "	44.52	22.76	3.64	25.81	3.27
Gallas Point (Light Grey).	59.09	1.13	2 35	32.28	5.15
" " " "	60.33	1 10	2.20	33 13	3.24
Mean " "	59.71	1.115	2 27	32.70	4 205
Gallas Point (Brown)	53.60	1.65	5.53	33.43	2 79
" " "	53.82	1 82	5.36	33.28	2.72
Mean "	53.71	1.735	5.445	33.355	2.755
New London	59 37	0 95	2.52	35.70	1.46
" "	59.52	1.04	2.47	35.52	1.45
Mean	59 445	0.995	2.495	35.61	1.455

The iron has been set down above as peroxyd, although a portion of it may in some cases have occurred as carbonate. The insoluble residue was found to consist principally of silica.

From a comparison of the above analyses, it is seen that the Miminigash is the purest limestone, and that the lime made from it might be employed for many purposes in building; for the finer work in the interior of houses it probably would not answer so well. Any of the above limestones, however, on being burned would make excellent fertilizers.

It has been supposed that dolomite is injurious as a manure for soils, but, according to Dana, this is not the case unless used before being fully air-slaked. The Kildare dolomite might, therefore, be used as well as the limestones.

3.—Copper.

The copper ore of Governor's Island was found to consist chiefly of copper glance (subsulphide of copper), but had a small amount of iron pyrites mixed with it.

The surface of the nodules is covered with the green carbonate of copper, and many of them were found to contain carbonaceous matter, portions of plants having formed the centres of concretionary action. In order to obtain an average sample, a number of the nodules were ground up together. The following are the results of two assays:—

	1.	2.	Mean.
Metallic Copper	43.054	43.53	43.292

This is, therefore, a rich and valuable ore; but so far as at present known, the quantity to be obtained is inconsiderable.

4. FOSSILS OF THE CARBONIFEROUS AND TRIASSIC FORMATIONS IN PRINCE EDWARD ISLAND.

1. Upper Carboniferous.

1. *Dadoxylon (Araucaroxylon) materiarium.*—Dawson.—(Plate I.)

Silicified trunks of this species abound at Gallas Point, and are also found at Miminigash and Sable River. At Gallas Point some of the specimens are calcified, and some are in part converted into peroxyd of iron. The flattened carbonised trunks found in the same beds also seem to belong to this species. Many of the trunks seem to have been much decayed previous to fossilization, and the fissures and cavities formed by decay have often been filled with a flesh-coloured crystalline sulphate of Baryta. After careful microscopic examination, I cannot distinguish the

structure from that of the specimens so abundant in the Upper Coal formation of Nova Scotia. The species was first described by me in the Canadian Naturalist, viii., 1863, and subsequently in the second edition of Acadian Geology, p. 473.

In the Nova Scotia specimens I have described a transversly-marked pith of the character of Sternbergia, and this occurs also in the specimens found in Prince Edward Island. Fig. I. Plate 1., shows a small but well-preserved stem with its pith in place, and is in this respect one of the most perfect specimens of this tree that I have obtained.

Some of the stems found at Gallas Point show coarse Knorria-like markings on the surface; but, though probably coniferous, the structures of these are not sufficiently well preserved for accurate comparison.

2. *Walchia (Araucarites) gracilis.*—Dawson.—(Plate II. Fig. 23.)

This species was first described by me in 1863*, from a specimen found in the Upper Coal formation of Tatamagouche, Nova Scotia. Specimens from Miminigash are perfectly similar, except that the branchlets are somewhat more closely placed. I have, in the publications above cited, stated my belief that these leafy branches have belonged to *Dadoxylon*, and probably to the species last mentioned. In Europe Walchia is regarded as Permian, while Dadoxylon is more characteristic of the Carboniferous; but since they are probably the stems and branches of the same genus of pines, they cannot be regarded as tests of geological age.

3. *Walchia (Araucarites) robusta, S.N.*—(Plate II. Fig. 24.)

Branchlets densely pinnate, thick, and covered with numerous acicular leaves one-fourth of an inch or more in length.

This species is much larger and coarser than the last, exceeding in these respects the European *W. piniformis* of the Permian, which in general aspect it much resembles. It indicates a second species of Coniferous tree, possibly represented also by some of the fossil trunks, though I have not as yet been able to ascertain any distinction between them sufficient to warrant their separation into distinct species.

4. *Pecopteris arborescens.*—Schlotheim.—(Plate II. Fig. 16.)

The most abundant species in the red shales of Miminigash.

5. *P. rigida.*—Dawson.—(Plate II. Fig. 15.)

Also found at Miminigash, and, like the last, characteristic of the Upper Coal formation in Nova Scotia.

* Can. Nat., vol. viii. See also Acadian Geology, p. 474.

6. *P. oreopteroides?*—Brongt.——(Plate II. Fig. 17.)

Specimens occur at Miminigash much resembling this species, but the venation is not distinct.

7. *P. (allied to P. Gœpperti?*—Brongt.)

This is rare, and, its venation not being preserved, it cannot be determined.

8. *Alethopteris nervosa.*—Brongt.—(Plate II. Fig. 18.)

Occurs at Miminigash; it is also common in the Upper Coal-formation of Nova Scotia. The variety found at Miminigash has somewhat longer and more obtuse pinnules than usual.

9. *Neuropteris rarinervis.*—Bunbury.—(Plate II. Fig. 19.)

This occurs at Miminigash, under a large varietal form, which is also found in the Middle Coal-formation at Sydney, Cape Breton. Some of the terminal pinnæ appear very near to *N. tenuifolia* of Brongt.

10. *Cordaites simplex.*—Dawson.—(Plate II. Fig. 22.)

This species, which is very characteristic of the Upper Coal-formation in Nova Scotia, is not infrequent at Miminigash, where its large striated leaves appear abundantly on the surface of some of the beds of shale.

11. *Alethopteris Massilionis.*—Lesq.

A few pinnules in one of the shales from Miminigash indicate a species of Alethopteris, with the nerves of *A. Dournaisii* and the form of *A. Grandini.* It is apparently the same species described by Lesquereux under the above name, and which also occurs at Sydney, Cape Breton, where, however, I believe, it has been included with *A. Grandini.*

12. *Calamites Suckovii.*—Brongt.

This common species was found at Campbellton and at Gallas Point.

13. *C. Cistii.*—Brongt.—(Plate II. Figs. 10, 11.)

Found at Miminigash and at Gallas Point; also at Governor's Island.

14. *C. gigas.*—Brongt.—(Plate II. Fig. 14.)

This remarkable and interesting species, found in the Permian in Europe, was collected by Mr. Taylor at Gallas Point.

15. *C. arenaceus?*—Jager.—(Plate II. Figs. 12, 13.)

The fragments represented in Figs. 12 and 13 may belong to a plant allied to this species; they were found at Gallas Point. It was, no doubt, a *Calamodendron* rather than a Calamite proper.

16. *Trigonocarpum*.—(Plate II. Figs. 20, 21.

A species allied to *T. Noeggerathi* but longer in proportion to its breadth, was found in the gray sandstone of Governor's Island.

It may be remarked of these plants in general, that they are species characteristic of the newest or upper members of the Coal-formation, and that some of them have even a Permian aspect. On the whole, however, they may be regarded as coinciding with those of the upper members of the Newer Coal-formation of Nova Scotia and New Brunswick.

2. Trias.

1. *Dadoxylon* (*Araucaroxylon*) *Edvardianum*, S. N.—(Plate III. Figs. 25 to 27.)

Stems without distinct rings of growth, and with a central pith not observed to have transverse laminæ. Wood-cells with one, or rarely two, rows of contiguous hexagonal areoles. Medullary rays simple, infrequent, with two to ten rows of cells superimposed.

This species is represented by small calcified and decorticated stems and branches, found by Dr. Harrington in the Lower Trias at Indian River. Its nearest allies are *D. Keuperianum* Endlicher, from the Trias of Europe, and *D. cupreum*, of Goeppert, from the Permian. It has also some points of resemblance to a species figured by Eichwald, from the Permian of Russia.

Most of the specimens from Indian River are remarkable for being riddled with small rounded holes, filled with calcite, which give them at first sight the appearance of endogenous stems. These holes are very similar to those made by the living crustacean *Limnoria terebans* in submerged timber, and are probably the work of some similar creatures inhabiting the Triassic sea. (Fig. 27.)

2. *Cycadoidea* (*Mantellia*) *Abequidensis*, *N.S.*—(Plate III. Fig. 29.)

Stem Obovate (two-and-a-half inches long and two inches broad) bases of petioles small, transversely lozenge-shaped, crowded, one tenth of an inch or less in length. A few small round scars of buds or branchlets appear on the surface.

The specimen is flattened and mineralised by red oxyd of iron, and is contained in a gray argillaceous sandstone spotted with red. It was collected by Mr. Taylor in the neighbourhood of Gallas Point, and probably from the Lower Trias. It is a small species and imperfectly preserved, but is interesting as the first specimen of a Cycadean stem found in British North America. It bears some resemblance to *C. pygmaea* (L. & H.) but has much smaller scars, and would probably go into

the genus Mantellia of Carruthers; but as its structure is not preserved, I have thought it best to let it remain in the less restricted genus Cycadoidea.

Its specific name is taken from Abequid—" lying on the water," the ancient Micmac name of Prince Edward Island.

3. *Knorria.*—(Plate III. Fig. 30.)—In this provisional genus I may for the present place the stems one of which is represented in fig. 30, plate III, and which are not infrequent in the Lower Trias. They very closely resemble the Permian stems to which Eichwald has given the name *Schizodendron;* but they cannot be what he supposes his specimens to be, viz., endogens allied to *Liliaceæ*. On the contrary, they show traces of woody tissue allied to Conifers, and I suppose it most likely that they are branches of pines, if not ligneous cylinders of Cycadaceous plants, which, however, from their length and slenderness, I think less likely. Their markings are similar to those of the stems from Gallas Point, already referred to under *Dadoxylon materiarium*.

4. *Sternbergia.*—(Plate III. Fig. 28.)—Flattened branches with a transversely-marked pith, are found both at Murray Harbour and near Penn Point, in the Lower Trias. They show traces of coniferous tissue, and may have belonged to branches of Dadoxylon.

5. *Fucoids.*—Of this character are probably the cylindrical stems referred to in the previous part of this report as so abundant in the Triassic sandstones, and also certain slender angular branching bodies occurring in the calcareous beds. In the high cliff at the south side of Orwell Bay we also found in the soft red sandstone traces of a slender diffuse pinnate plant with irregular distant pinnules. The specimens were very obscure, but may have belonged to a fucoid of the type known as *Caulerpites*.

Fossil Reptile.

The most remarkable fossil of the Trias of Prince Edward Island is the jaw bone of the reptile described by Leidy in the Philadelphia Transactions under the name of *Bathygnathus borealis*. It was discovered by Mr. D. McLeod at New London, and is now in the museum of the Academy of Natural Sciences at Philadelphia. It belongs to the group of Dinosaurian reptiles so characteristic of the Mesozoic Period. We were not so fortunate as to discover any additional specimens; but to complete my notice of the fossils of the Trias, and to enable additional remains to be recognised should they be found, I give in plate III. fig. 31, a reduced copy of Dr. Leidy's figure.

CATALOGUE OF SPECIMENS OF FOSSILS, ROCKS AND MINERALS OF PRINCE EDWARD ISLAND.

(Deposited in the Provincial Building, Charlottetown.)

1.	Dadoxylon materiarium	Gallas Point.
2.	" " with sulphate of Baryta	" "
3.	Dadoxylon "	Sable River.
4.	Dadoxylon materiarium	Miminigash.
	All the above are silicified.	
5.	" " oxyd of iron	Gallas Point.
6.	" " coaly	" "
7.	" " "	" "
8.	Pecopteris arborescens	Miminigash.
9.	Neuropteris rarinervis	"
10.	Pecopteris oreopteroides	"
11.	Alethopteris nervosa	"
12.	Pecopteris rigida	"
13.	Cordaites simplex	"
14.	Calamites Cistii	"
15.	" "	Gallas Point.
16.	" "	Governor's Island.
17.	Walchia robusta	Miminigash.
18.	Coniferous tree with "Knorria" markings	Gallas Point.
19.	Trigonocarpum	Governor's Island.
20.	Calamite in ferruginous concretion	Gallas Point.
21.	Stem, ferruginous	" "
22.	Carbonised Plant *	" "
23.	" " *	" "
24.	Concretion enclosing fossil plant	" "
25.	Concretionary limestone with carbonized plants	" "
26.	" " (brown)	" "
27.	Mottled mud-rock	" "
28.	Red clay	" "
29.	Brown sandstone	" "
30.	Micaceous "	" "
31.	Sandstone with manganese	" "
32.	Mottled sandstone	" "
33.	Concretionary iron ore	" "
34.	Concretionary Iron Ore	Governor's Island.
35.	Slab with markings	Miminigash.
36.	Concretionary limestone	Governor's Island.
37.	Grey sandstone	" "
38.	Brown ferruginous sandstone	" "
39.	Coarse grey "	" "
40.	Cupriferous "	" "
41.	Copper ore (Chalcocite)	" "
42.	Grit	" "
43.	Calcareous shale, with fucoids	Miminigash.
44.	Mottled shale	"
45.	Limestone	"

* Collected by Mr. Taylor.

46. Arenaceous shale..Miminigash.
47. Coarse sandstone..Campbellton.
48. White " .... "
49. Coarse " .... "
50. Concretionary limestone.. "
51. Red sandstone .... "
52. Stems of Fern..Gallas Point.
53. Concretionary limestone..Governor's Island.
54. Fern Stipe and Pecopteris..Miminigash.
55. Red sandstone ....Near Belfast.
56. Reddish brown sandstone.. " "
57. Rippled sandstone.. " "
58. Mottled " .... " "
59. Grey " with fossil.. " "
60. Coarse red " .... " "
61. Grey " ....Point Penn.
62. Brown " .... " "
63. Red " .... " "
64. Red clay.. " "
65. Ferruginous concretion .... " "
66. Knorria.. " "
67. Fossil stem .... " "
68. Sternbergia..Murray Harbour.
69. Fucoid (Caulerpites)..Cliff near Belfast.
70. Conglomerate..Wood Islands.
71. Red sandstone .... " "
72. Grey sandstone .... " "
73. Red " ....Murray Harbour.
74. Fossil stems .... " "
75. Concretionary sandstone.. " "
76. Red sandstone ....Souris.
77. Sandstone with Fucoids..East of St. Peter's.
78. Red sandstone .... " "
79. " " Mount Edward Quarry ....Charlottetown.
80. Concretionary limestone..Charlottetown Harbour.
81. Red sandstone .... " "
82. Grey band (in red sandstone).. " "
83. Calcareous sandrock ....Indian River.
84. Red sandstone .... " "
85. Calcareous sandstone with Fucoids .... " "
86. Brown sandstone.. " "
87. Conglomerate .... " "
88. Fossil wood (Araucarites) .... " "
89. " " " .... " "
90. Red sandstone ....Cape Traverse.
91. Impure Concretionary limestone .... " "
92. Calcareous sandstone..Cape Egmont.
93. Micaceous " .... " "
94. " " .... " "
95. Reddish " .... " "
96. Arenaceous shale .... " "
97. Grey sandstone (in red band) .... " "
98. Grey sandstone ....Bannockburn.
99. Red " .... "

100.	Micaceous sandstone	Indian Point.
101.	Calcareous concretion	" "
102.	Concretionary limestone	" "
103.	Calcareous sandstone	Curtain Island.
104.	" concretion	" "
105.	Grey sandstone (thin band)	" "
106.	Red sandstone	Darnley.
107.	Calcareous sandstone	"
108.	Impure concretionary limestone	"
109.	Mottled sandstone	"
110.	Red sandstone	New London.
111.	Limestone (concretionary)	" "
112.	" (McLeod's)	" "
113.	Mottled sandstone with Fucoids	Cape Tryon.
114.	Vein of calc. spar	" "
115.	Altered red sandstone	Hog Island.
116.	Red sandstone	Southern end of " "
117.	Compact trap	" "
118.	Amygdaloid	" "
119.	Tufa	" "
120.	Trap (slicken-sided)	" "
121.	Wacke	" "
122.	Peat	Lower half of Black Bank.
123.	"	Upper " " " "
124.	Calcified wood (Dadoxylon)	Gallas Point.

APPENDIX.

LIST OF MOLLUSCA OBSERVED IN PRINCE EDWARD ISLAND.

The following species were collected by Mr. W. B. Dawson, in the course of our excursions. They are sufficient to show that the invertebrate fauna of Prince Edward Island, like that of the opposite coast of Nova Scotia and New Brunswick, is essentially of a New England type, and very different from that of the River St. Lawrence north of Gaspé, which seems to form the dividing line between the warmer fauna of Northumberland Strait and the more boreal fauna extending northward to Labrador. We had intended to explore the deeper parts of Northumberland Strait by dredging; but did not find opportunity. The names in the following list are those of the second edition of Gould's Invertebrata.

1. *Teredo Norvegica?* In sunken timber.
2. *Zirfea crispata*, Lin. Boring in red sandstone reefs.
3. *Solen Americanus*, Gould. This shell, common in Northumberland Strait, is regarded by Dr. P. P. Carpenter as certainly distinct from *S. ensis*, Lin.
4. *Mya arenaria*, Lin. Common and large. Some small specimens were found living in the burrows of Pholads.
5. *Mactra solidissima*, Chemn.
6. *Cummingia tellinoides*, Conrad. Only one specimen seen.
7. *Saxicava rugosa*, Penn. Burrowing in reefs of red sandstone and shale.
8. *Petricola pholadiformis*, Lin. Burrowing in reefs of red sandstone and shale.
9. *Macoma fusca* (*Tellina groenlandica*,) Say.
10. *Astarte sulcata*, Da Costa. A somewhat typical variety.
11. *Cytherea convexa*, Say.
12. *Venus Mercenaria*, Lin. Also the variety from *V. præparca*, not rare.
13. *Gemma Gemma*, Totten.
14. *Cardium pinnulatum*, Conrad.
15. *Unio complanatus*, Solander.
16. *Unio radiatus*, Gmelin.
17. *Mytilus edulis*, Lin.
18. *Modiola plicatula*, Lam.
19. *Pecten tenuicostatus*, Mighels.
20. *Ostrea Virginiana*, Lister. And Var. *borealis*. See notice in report above.
21. *Anomia ephippum*, Lin. On stones in deep water.
22. *Tectura testudinalis*, Müll.
23. *Tectura alveus*, Conrad. Rare.
24. *Crepidula fornicata*, Lin.
25. *Littorina rudis*, Donovan.
26. *Littorina littorea*, Lin. Occurs abundantly and of large size on different parts of the coast, as it does also on the opposite shore of Nova Scotia, where I have collected the species abundantly, more than thirty years ago.
27. *Littorina palliata*, Say.
28. *Velutina haliotoidea*, Fabr.
29. *Lunatia heros*, Say.
30. *Lunatia triseriata*, Say.

31. *Purpura lapillus*, Lin.
32. *Nassa obsoleta*, Say.
33. *Nassa trivittata*, Say.
34. *Buccinum undatum*, Lin.
35. *Buccinum cinereum*, Say.
36. *Hyalina arborea*, Say.
37. *Hyalina chersina*, Say.
38. *Helix hortensis*, Müll. Yellow variety.
39. *Limnea elodes*, Say.
40. *Limnea humilis*, Say.
41. *Limnea reflexa*.
42. *Physa heterostropha*, Say.
43. *Ommastrephes Sagittatus*, Ferussac. This was the only species of cuttle fish that we found.

In addition to the above we collected the Sea-urchin, *Eurechinus drobachiensis;* the Cake-urchin, *Echinarachnius parma;* the Brittle-star, *Ophiopholis aculeata;* and two species of Acorn-shells, *Balanus porcatus* and *B. crenatus;* also a number of species of *Polyzoa* and *Foraminifera*.

EXPLANATION OF PLATES.

PLATE I.

Carboniferous Fossils.

Fig. 1. *Dadoxylan materiarium*—Trunk, natural size—(*a*) wood, (*b*) Pith.
" 2. Cross section—magnified 50 diameters.
" 3. Radial section—50 diameters.
" 4. Tangential section—50 diameters.
" 7, 8, 9.—Pith of a smaller specimen, natural size and magnified.

PLATE II.

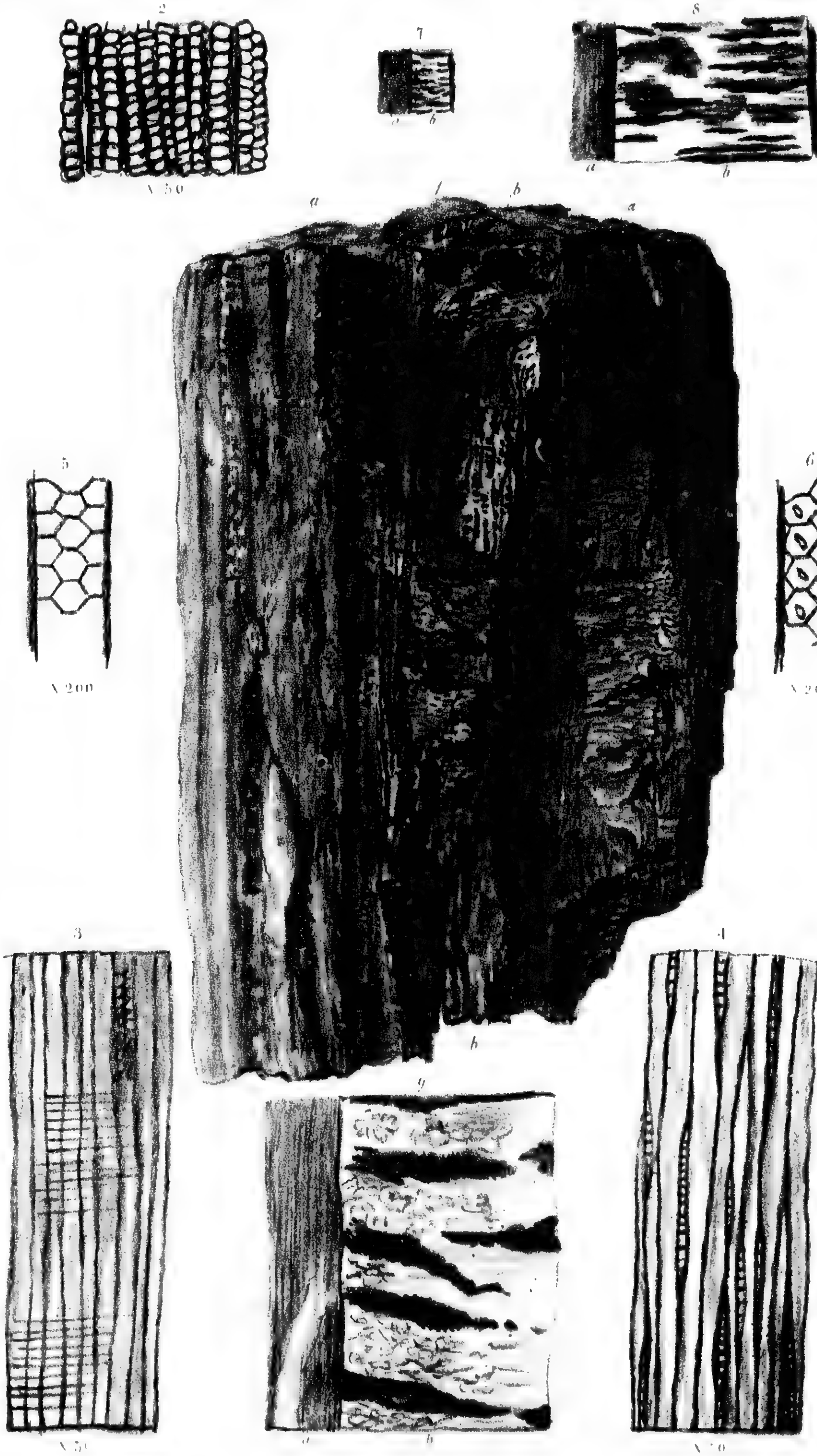
Carboniferous Fossils.

Fig. 10, 11. *Calamites Cistii.*
" 12. *C.* (*Calamodendron*) *arenaceus*, outer surface.
" 13. Do. do. cast of pith.
" 14. *Calamites gigas.*
" 15. *Pecopteris rigida*—15 *a*, Pinnule enlarged.
" 16. *Arborescens*—16 a, Pinnules enlarged.
" 17. *P. oreopteroides ?*
" 18. *Alethopteris nervosa*—18 *a*, Pinnule enlarged.
" 19. *Neuropteris rarinervis.*
" 20, 21. *Trigonocarpum.*
" 22. *Cordaites simplex.*
" 23. *Walchia gracilis.*
" 24. *W. robusta.*

PLATE III.

Triassic Fossils.

Fig. 25. *Dadoxylon Edvardiamum*—tangential section, 100 diameters.
" 26. Do. —radial section, 100 diameters.—26 *a*, two cells, 200 diameters.
" 27. Do. —transverse section, 20 diameters, showing burrows of boring animals at (*a*, *a*).
" 28. Stem with sternbergia pith.
" 29. *Cycadoidea Abequidensis*—29 *a*, leaf-scars enlarged ; 29 *b*, scars of buds enlarged.
" 39. Knorria—30 *a*, marking enlarged.
" 31. *Bathygnathus borealis.* Lower jaw after Leidy, reduced ; 31 *a*, sections of teeth natural size ; 31 *b*, serrated edge of tooth enlarged.



DADOXYLON MATERIARIUM.

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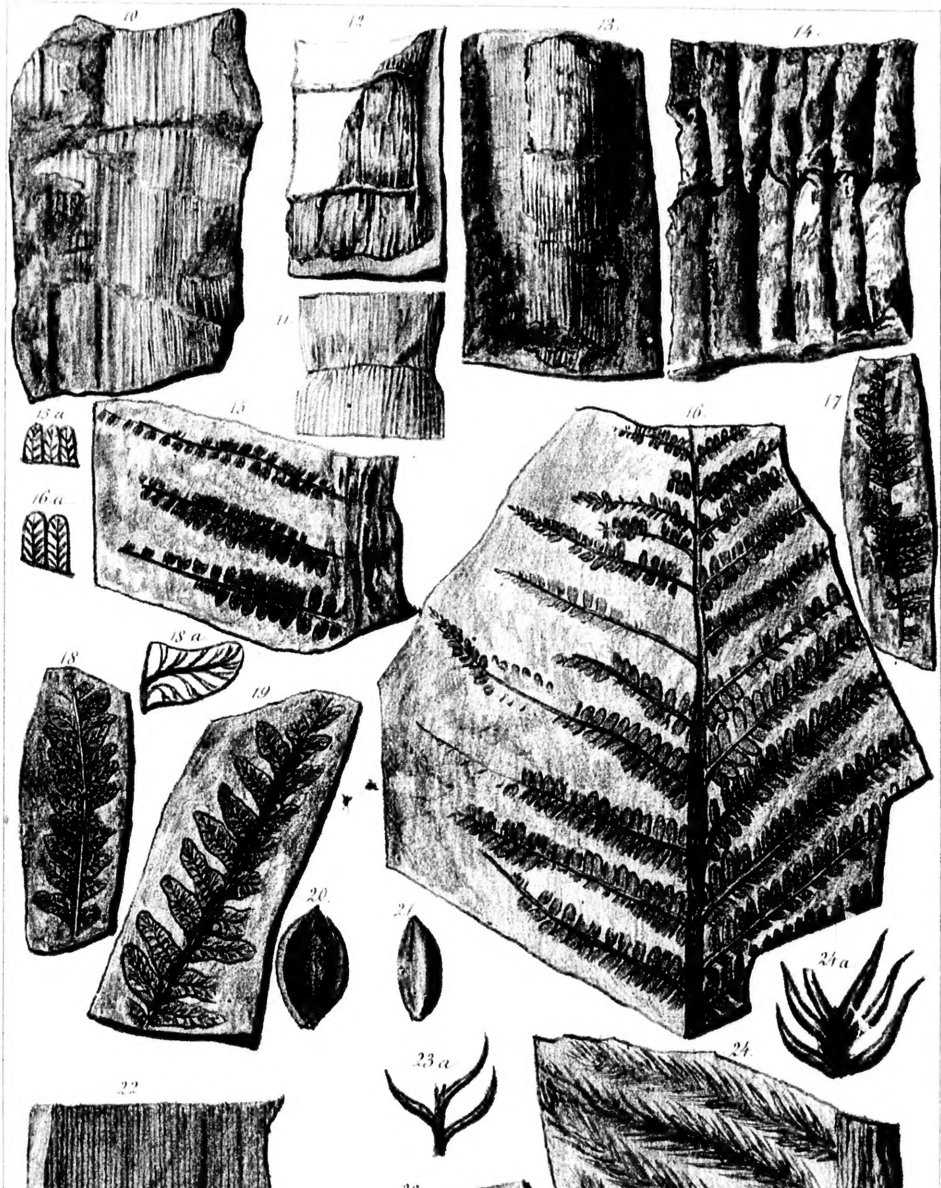
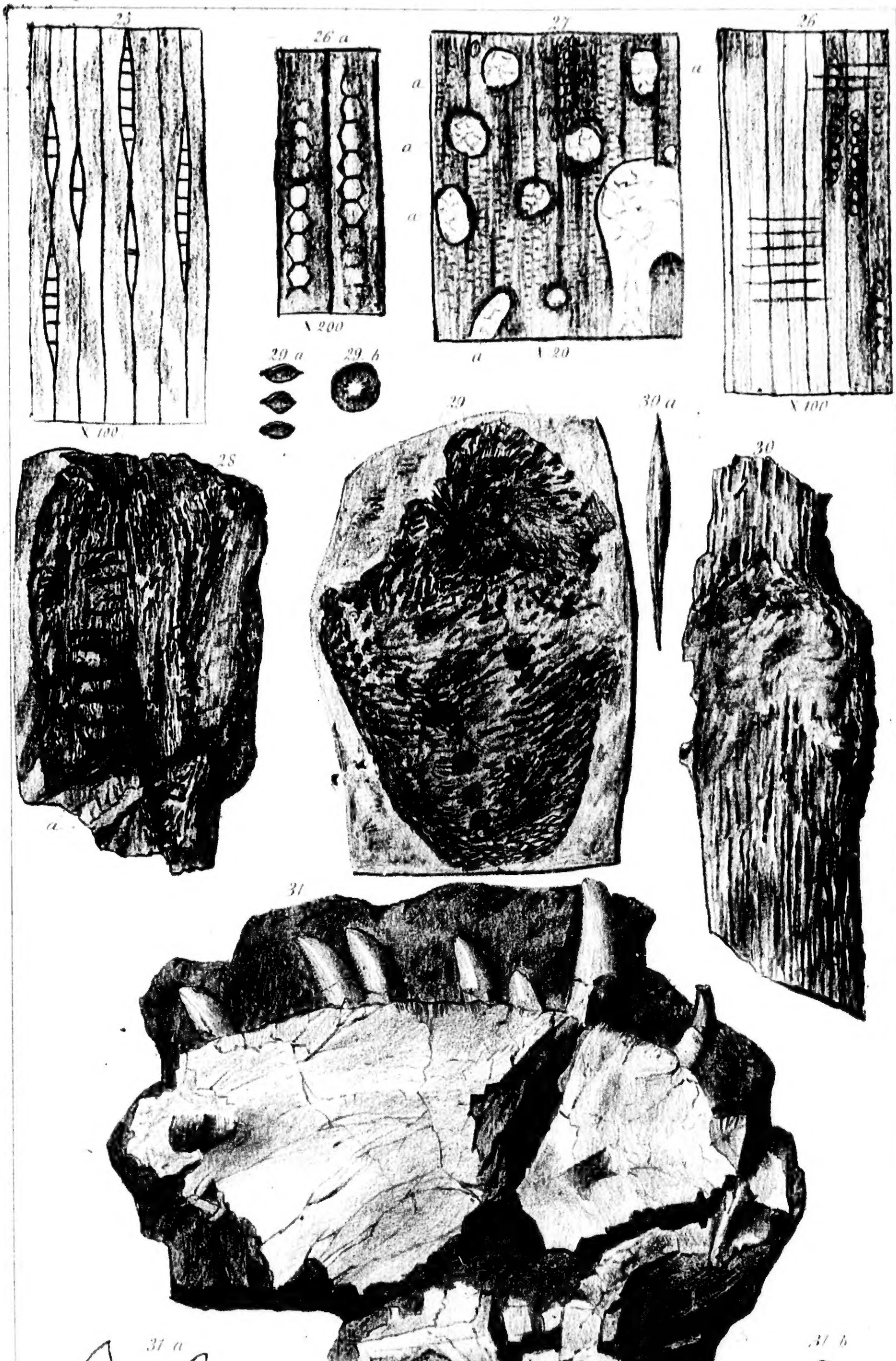


CALAMITES, FERNS, &C



TRIASSIC FOSSILS.